HNOLOGY DEPT.

Midyear Report

L AND GAS URNAL

Merely Making PARTS AVAILABLE is not

WHAT FRANKS CONSIDERS FIELD SERVICE

FRANKS MFG CORP. WELL SERVICING AND DRILLING UNITS

"On the SPOT" FIELD SERVICE =

STOCK of PARTS, There
Plus
TRAINED PERSONNEL, There
Plus
SHOP FACILITIES, There
Plus
24-HOUR SERVICE, There

This, as are all other stations on the map, is a typical Franks "on the spot" service center. This Odessa center shows the service manager's home nearby, so that he is available on call 24 hours a day.

FRANKS MFG CORP. WELL SERVICING AND DRILLING UNITS

FRANKS MANUFACTURING CORP.
Box 3218 Tulsa, Oklahoma

Franks believes that the best drilling and servicing units are only as good as the manufacturer's field service organization. That's why Franks field service is more than the mere availability of parts; why Franks staff at each center is made up of factory trained men; why Franks has "on the spot" shop facilities, each shop being a complete repair and modification center; why Franks service center managers live on the site so as to provide 24 hour, day and night, service, including Sundays and holidays.

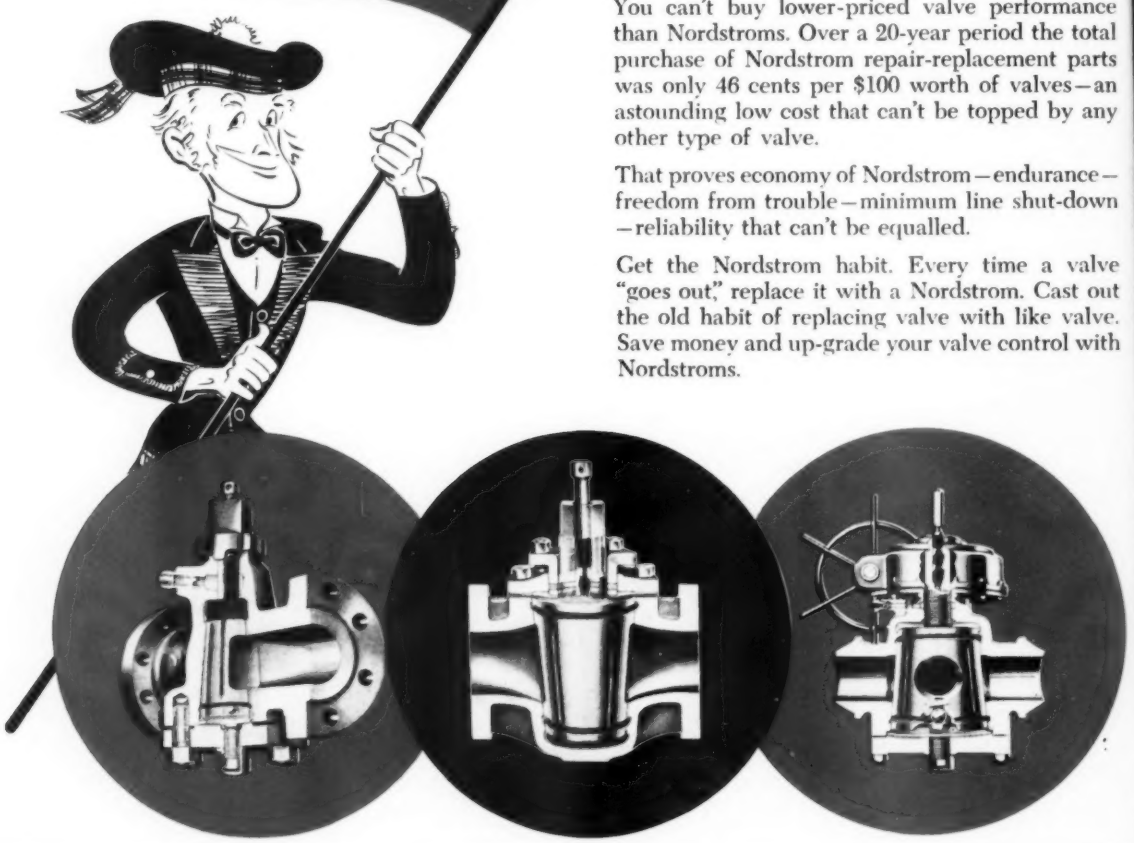
Franks service center managers represent in excess of 10 years of service per man with Franks. They are qualified and will be glad to discuss with you how Franks units can meet your needs.

XUM

A NEW LOW

IN VALVE REPLACEMENT COSTS

1/2 OF 1%
OVER 20 YEAR PERIOD



How many valves in your operations have served for 20 years with repairs costing less than ½ of 1%? We'll venture to say few, if any—unless they are Nordstroms.

You can't buy lower-priced valve performance than Nordstroms. Over a 20-year period the total purchase of Nordstrom repair-replacement parts was only 46 cents per $100 worth of valves—an astounding low cost that can't be topped by any other type of valve.

That proves economy of Nordstrom—endurance—freedom from trouble—minimum line shut-down—reliability that can't be equalled.

Get the Nordstrom habit. Every time a valve "goes out," replace it with a Nordstrom. Cast out the old habit of replacing valve with like valve. Save money and up-grade your valve control with Nordstroms.

Nordstrom Valves

PATENTS APPLIED FOR

NOW AUTOMATICALLY LUBRICATED WITH Hypermatic

TRADE MARK

***Nordstrom Valve Division*—ROCKWELL MANUFACTURING CO.**
400 North Lexington Avenue, Pittsburgh 8, Pa., Offices in all principal cities

ROCKWELL

Export — Rockwell Mfg. Co., International Division, Empire State Building, New York 1

XUM

XUM

even by the strict standards of ball and roller bearing manufacture...

Magnifying Comparator for checking raceway curvature with Master Curve Gauge.

LINK-BELT *is outstanding*

▶ *because* of the most modern precision production

As a user of bearings, you want long life and absolute interchangeability of parts. Long life in a ball or roller bearing results from proper design and extreme accuracy of manufacture. The finest production tools, the latest and best manufacturing methods, make the LINK-BELT a most modern bearing.

▶ *because* of quality control

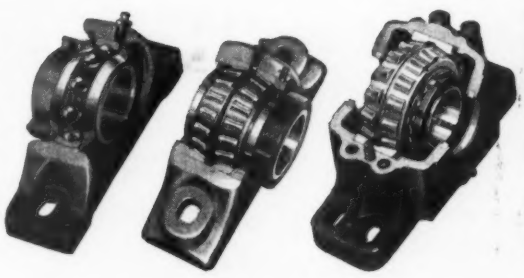
Rigid "in process" inspection checks quality at every step of manufacture, from raw material to finished product. Laboratory technicians are constantly testing bearings under every conceivable condition of operation. Every precaution is taken to make certain that LINK-BELT bearings will give maximum life and efficiency.

We invite you to use the services of the Link-Belt Bearing Engineer. His advice and cooperation is yours without obligation.

You will also find our Data Book No. 2550 a handy engineering aid. May we send you a copy?

LINK-BELT COMPANY Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Minneapolis 5, Houston 1, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Johannesburg. Offices, Factory Branch Stores and Distributors in Principal Cities. 11,800

A complete line of bearings is available from stock, throughout the country, in pillow blocks, cartridge, flanged cartridge, flanged, hanger and takeup blocks —also unmounted bearings.



LINK-BELT

BALL & ROLLER

BEARINGS

XUM

No Man
in the Picture
. . . and that's the way you usually see Fairbanks-Morse "ZC" Engines . . . and a big reason why they're the favorites in the fields. They rarely require attention or maintenance. Just start them and forget them. They keep right on going. There are no complicated parts . . . no delicate adjustments to cause trouble, and that's an important point with present-day high maintenance labor costs. See your supply store about a "ZC" Engine and forget your pumping problems. Fairbanks, Morse & Co., Chicago 5, Illinois.
FAIRBANKS-MORSE,
a name worth remembering
OIL FIELD EQUIPMENT • DIESEL LOCOMOTIVES AND ENGINES • ELECTRICAL MACHINERY • PUMPS • SCALES • HOME WATER SERVICE AND HEATING EQUIPMENT RAIL CARS • FARM MACHINERY

MACWHYTE WIRE ROPE AND SLINGS

engineered to save you money on the job

Ask Macwhyte to recommend the type and size of wire rope best suited for your needs. *There are a thousand and one wire ropes made by Macwhyte.*

Specifications for the correct sling for any lifting need are yours from Macwhyte for the asking.

Prevent loss!
Save time!
Be sure!

MACWHYTE WIRE ROPE:

Available in the complete Macwhyte line are Internally Lubricated *PRE*formed Wire Ropes for all equipment—plus Galvanized, Stainless Steel, and Monel Metal Wire Ropes. Also available are special assemblies of Macwhyte Wire Rope and Industrial Standards "Safe-Lock" fittings. Fittings are attached to rope by swaging—and assemblies are made to order.

MACWHYTE SLINGS:

Available in all types, sizes and lengths, to meet almost any lifting requirement. Macwhyte ATLAS Round-Braided Slings, Drew Flat-Braided Slings and Monarch Single-Part Wire Rope Slings are all made to order to fit your needs. Illustrated is a special Macwhyte Drew 14-part Type 1CT Flat-Braided Sling.

WHATEVER YOUR NEEDS

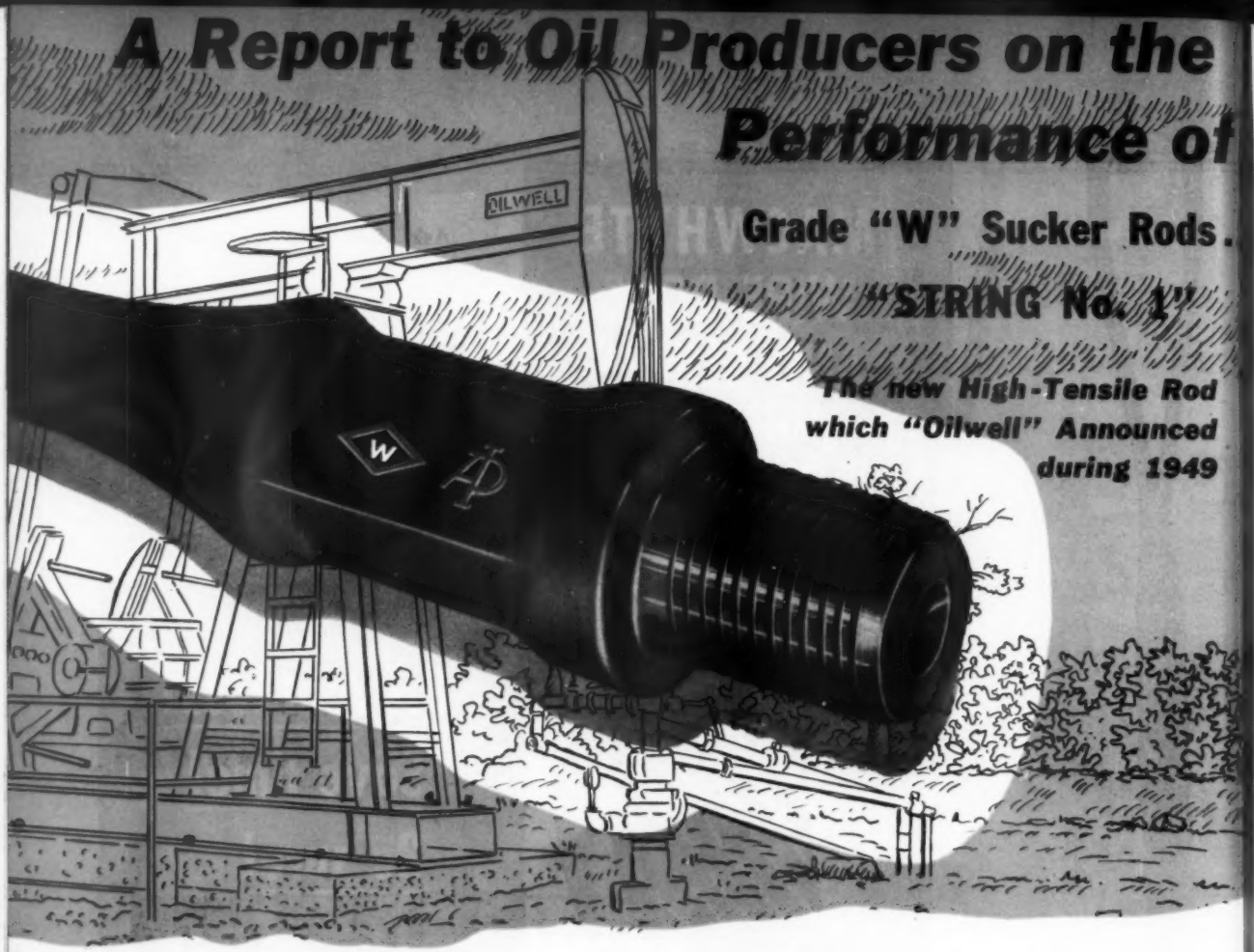
for wire rope, slings, special assemblies, solutions for special problems, ask a Macwhyte distributor or write direct to Macwhyte Company for suggestions and recommendations.

MACWHYTE COMPANY, *2916 Fourteenth Avenue, Kenosha, Wisconsin. Manufacturers of Internally Lubricated Wire Rope, Braided Wire Rope Slings, Aircraft Cables and Assemblies, Monel Metal and Stainless Steel Wire Rope. Our distributors and mill depots throughout the U.S.A. and other countries carry stocks for immediate delivery. Catalog on request. Mill Depots: New York • Pittsburgh • Chicago • Minneapolis • Fort Worth • Portland • Seattle • San Francisco • Los Angeles*

691SW

XUM

A Report to Oil Producers on the Performance of Grade "W" Sucker Rods. "STRING No. 1"



The new High-Tensile Rod which "Oilwell" Announced during 1949

On December 2, 1947 . . . the first string of "Oilwell" Grade "W" Sucker Rods started its "test run" in a California well . . . activating a 1¾-in. insert-type pump, set at 6,483 feet in 2½-in. tubing.

So that this field test* could be as conclusive as possible, other-make high-tensile rods, which had previously given the best service in this well, were used immediately BELOW the corresponding size of "Oilwell" Grade "W" rods in the string . . . which was tapered as follows:

34 joints — ⅞" "Oilwell" Grade "W" Rods
6 joints — ⅞" Other-Make High-Tensile Rods
174 joints — ¾" "Oilwell" Grade "W" Rods

100-inch strokes at the rate of 8-per-minute is the normal operating rate for this well; but peak polished-rod loads beyond 40,000 lbs. p.s.i. at 13 SPM were recorded by dynagraph.

Pumping is continuous. During the first eleven months following installation, breaks occurred twice in the 6-joint segment of the "other-make" rods. This segment was later replaced with 1" rods of same make.

On May 15, 1950 (as this advertisement was being released for publication) "String #1 of 'Oilwell' Grade 'W' Sucker Rods" had been in operation for 895 days without a break . . . and was still performing beautifully.

"Oilwell" Grade "W" Sucker Rods

. . . give you reasonably priced rod strings for long-stroke, slow-speed pumping applications . . . where high stresses are encountered . . . and where corrosive conditions are mild.

Because . . . of their higher fatigue resistance, you can reduce operating costs by using:

1. Longer string segments before tapering to larger rod sizes.
2. Smaller size tubing. (¾" rods can be used in 2" tubing where ⅞" rods would require undersize couplings).
3. Smaller pumping unit requirements.
4. Higher factor of safety against breakage.

*"Oilwell" Representatives *can give you complete details on this test . . . and GIVE YOU FACTS on the complete line of "Oilwell" Sucker Rods that will enable you to select the most economical grade for your requirements.*

OIL WELL SUPPLY COMPANY

Branches Serving All Oil Fields

Executive Office—DALLAS, TEXAS
Export Division Office—
30 ROCKEFELLER PLAZA
NEW YORK 20, N. Y.

Division Offices—CASPER, WYOMING
COLUMBUS, OHIO . . . DALLAS, TEXAS
HOUSTON, TEXAS . . . TULSA, OKLAHOMA
LOS ANGELES, CALIFORNIA

USS "OILWELL" TRADE MARK

UNITED STATES STEEL

Style... Comfort... Economy...

go hand in hand

MANUFACTURERS OF SPECIAL MILLWORK: DISTRIBUTORS OF JOHNS-MANVILLE BUILDING MATERIALS; CURTIS WOODWORK

Over 30 years experience has taught Southern Mill how to manufacture prefabricated buildings that fill the bill for style . . . comfort and economy. STURDY-BILT Houses are built to last, too. They can be transported anywhere, and erected in days instead of weeks. For immediate delivery of any oil field housing you need . . . phone or write today.

STURDYBILT

SOUTHERN MILL & MANUFACTURING CO.

Tulsa, Oklahoma

Prefabricated, Demountable Houses

PREFABRICATED HOME MANUFACTURERS' INSTITUTE phmi

STURDYBILT HOUSES COMPLY WITH COMMERCIAL STANDARD CS125-45 OF THE NATIONAL BUREAU OF STANDARDS FOR PREFABRICATED HOMES

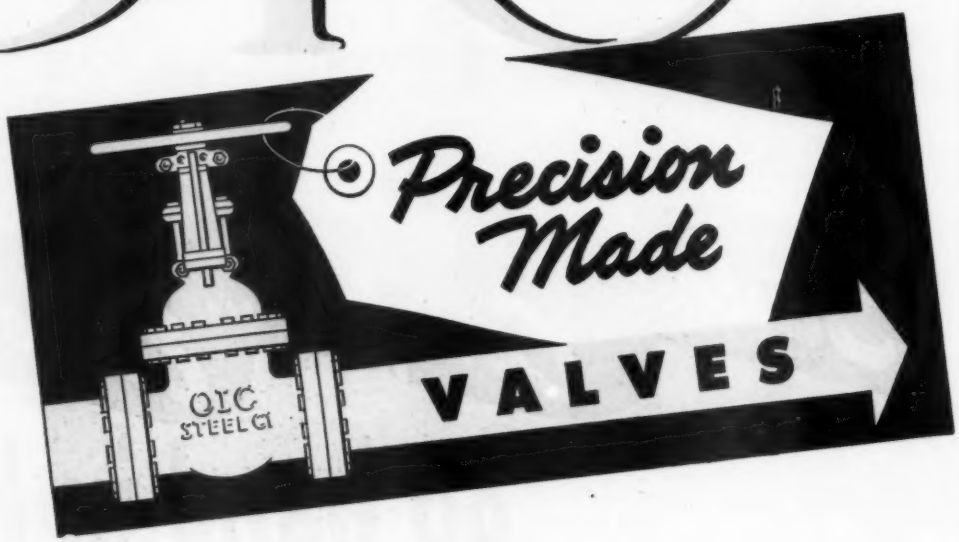
The Oil and Gas Journal, published Thursdays by The Petroleum Publishing Company. Entered as second-class matter September 1, 1910, at post office at Tulsa, Okla., under act of March 3, 1879. U. S. and foreign rates to the petroleum industry, $3 yearly. Copyright 1950.

XUM

JUST SAY

OIC

FOR



For any valving requirement, you can specify OIC Valves and be sure of efficient, precise control. That's because OIC Valves are:

PRECISION ENGINEERED—positive closure . . . minimum friction . . . designed for smooth, free flow of air, gases and liquids.

PRECISION BUILT—every essential part accurately finished for a precise fit, on the most modern production equipment.

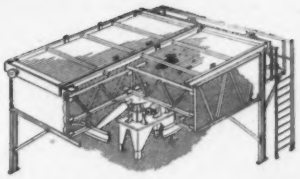
PRECISION APPLIED—OIC engineers always available to help you select valves best suited to each job, at lowest cost.

Here's a three-way combination that provides "*precision valve*" *equipment* in your plant. First costs and upkeep costs are lower. See your local OIC distributor, or write us direct. Ask for a free copy of the 1950 OIC Valve Cross-Reference Chart. The Ohio Injector Company, Wadsworth, Ohio.

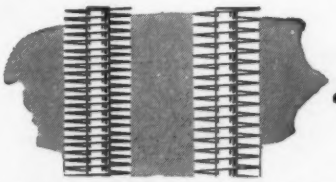
OIC
FOUNDED 1883

VALVES

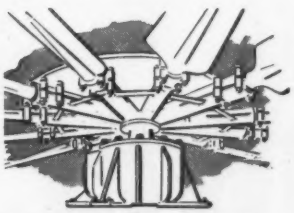
FORGED AND CAST STEEL · IRON · BRONZE



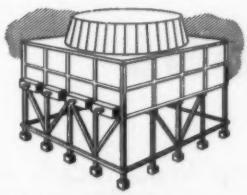
RIGID STRUCTURE . . . truss-sections give rigid but light design — requiring a small, inexpensive foundation. Rigidity assures longer-life coil sections.



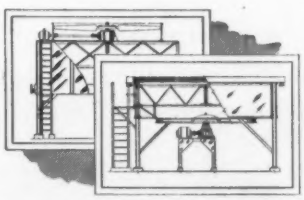
EFFICIENT FINNED TUBES . . . pressure bonded fins on tubes give high level heat transfer not dependent on solder joints. Various fins, tubes and headers available to meet any application.



PROVEN MECHANICAL EQUIPMENT . . . multibladed fans and rugged Geareducers team up to give quiet, smooth and dependable operation . . . regardless of weather or location.

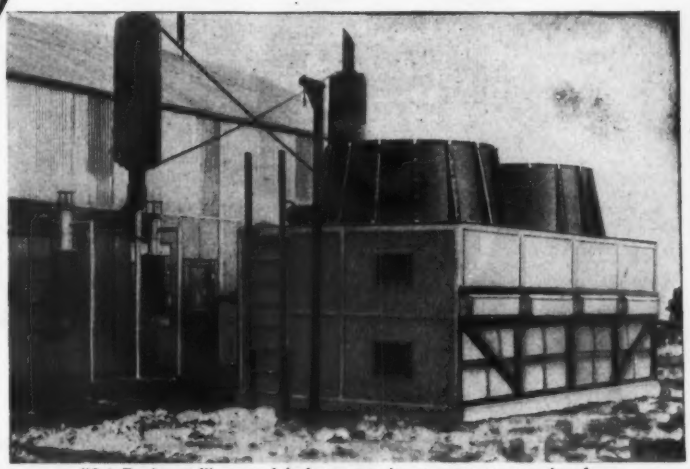


ALTERNATE MATERIALS . . . where corrosion is a problem, asbestos-board casing on a redwood frame requires little maintenance. Redwood, standard in cooling tower design, gives strong, durable and rigid support.



COMPLETE STANDARD LINE . . . induced draft or forced draft — portable or stationary — steel or redwood — various fin and tube materials and arrangements are offered by Marley to meet any application — usual or unusual.

Features like these . . . make MARLEY DriCooler® "JOB-ENGINEERED"



"Job-Engineered" to cool jacket water in temperatures ranging from −40F to 100F, an induced draft, asbestos-covered redwood structure.

No single design in an air-cooled heat exchanger will suit all applications. Cooling jacket water in below-zero temperatures, condensing gasoline on the sea coast or serving a pipeline compressor station in the desert . . . each is an exacting application . . . each requires a different type of unit. And that's why Marley has a complete line of DriCoolers available in all sizes and in a wide range of designs and materials.

After considering all factors, such as the fluids to be cooled — first cost — horsepower cost — weather conditions — corrosion and many other factors, Marley can make the best and most economical recommendation for your job.

Whether your job requires forced draft or induced draft design, steel or asbestos-board covered redwood structures, special fin or tube materials, you can be sure that your Marley DriCooler is "Job-Engineered" for your specific application.

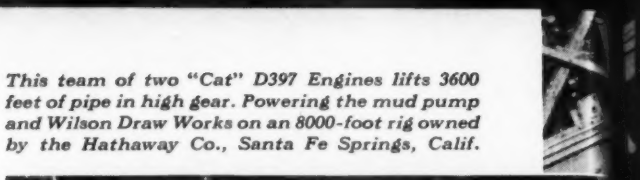
Let your Marley Application Engineer work with you from the "blueprint" stage on. Write, The Marley Company, Inc., Kansas City 15, Kans.

MARLEY

OG-7

Double-Flow Vairflo DriCooler Natural Draft Counter-Flow Aquatower Spray Nozzles

XUM



This team of two "Cat" D397 Engines lifts 3600 feet of pipe in high gear. Powering the mud pump and Wilson Draw Works on an 8000-foot rig owned by the Hathaway Co., Santa Fe Springs, Calif.

Two "Cat" D375 Oilfield Engines power the rig and mud pump for Steelco Drilling Corp., near Glenrock, Wyoming. Together they deliver over 600 hp. for hoisting under maximum conditions.

Big power

for big drill jobs

The big yellow "Cat" Engines have made a lot of friends among drillers, and it's the kind of friendship that *lasts*. For these units not only have plenty of power for deep drilling, but they're built with typical "Caterpillar" ruggedness—built to keep going with a minimum of maintenance or down time.

"Cat" Engines and Electric Sets are compact, simple in construction, easy to move from one location to another. Their long, dependable work life is backed by the top-notch, night-and-day service of "Caterpillar" dealers everywhere.

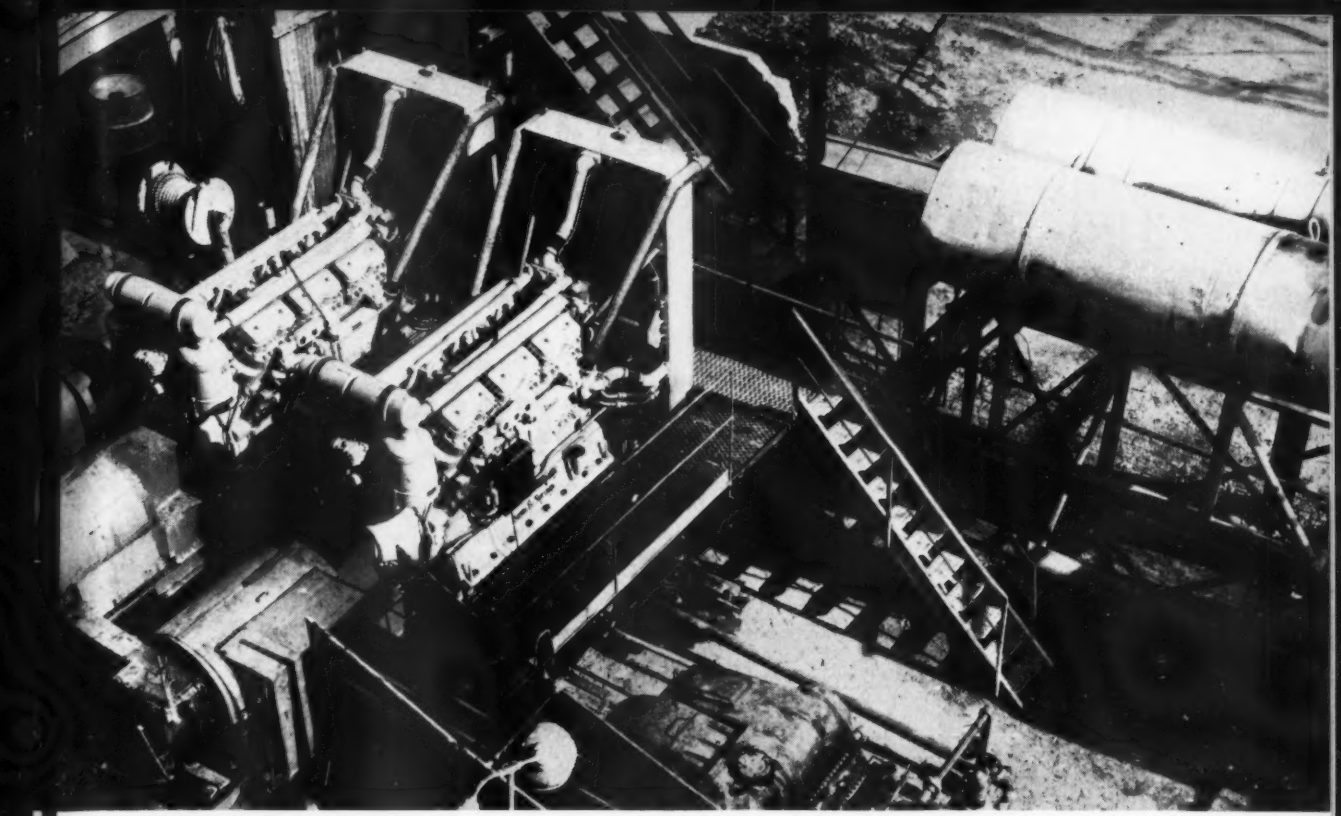
See your nearby "Caterpillar" dealer today. Ask him to *show* you the profit advantages of "Caterpillar" Oilfield Engines.

CATERPILLAR, PEORIA, ILLINOIS
REG. U.S. PAT. OFF.

CATERPILLAR
REG. U. S. PAT. OFF.

XUM

XUM



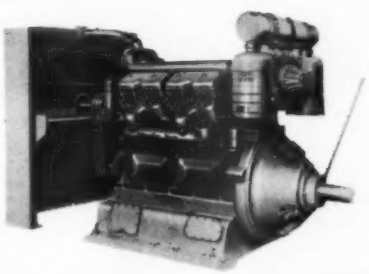
LOOK UNDER THE HIDE

The built-in quality in "Caterpillar" Engines doesn't show from the outside—but it shows up in performance. These are only a few of the hundreds of hidden quality features you find when you "look under the hide."

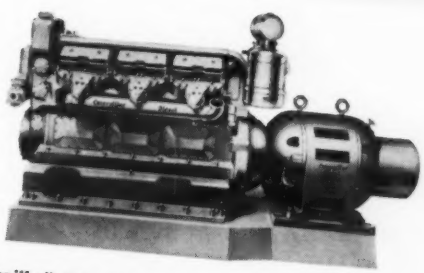
"Caterpillar" intake and exhaust valves are made of highly alloyed, heat-resistant steels. Their ample size and close machining and heat-treat specifications have resulted in thousands of hours of trouble-free valve operation. Valves on the D397, D386, D375 and D364 Engines have special hard facings on contact surfaces—and have valve rotators and hardened valve seat inserts to reduce wear.

The advanced design of the "Caterpillar" fuel injection valve offers owners maximum simplicity. Machined to extremely close limits, these valves are made from the finest quality materials—and are subjected to very detailed hardening processes. Valves are completely interchangeable and are adjustment-free. A large single orifice minimizes fouling. Owners use low-cost, non-premium fuels to get top-notch economy.

The heavy-duty crankshafts used on the "Caterpillar" D397 and D386 are forged of selected and pre-tested steel to assure highest quality. Integrally forged flanges, front and rear, provide permanently tight connections to drives. All bearing surfaces are "Hi-Electro" hardened and Superfinished for long life. Drilled passages provide oil for bearing lubrication and piston cooling. The crankshafts are dynamically balanced.



"Caterpillar" Oilfield Engines range from 49 to 500 hp. for hoisting under maximum conditions. Prices of standard enclosed clutch units range from $1919.50 to $16,260, f.o.b. Peoria, subject to change without notice.



"Caterpillar" Diesel Electric Sets, for powering electric rigs, range from 21 to 314 kw. Prices range from $2870 for self-regulated D311 to $19,635 for externally regulated D397, f.o.b. Peoria, subject to change without notice.

OILFIELD ENGINES

XUM

"Thanks to extra traction and proper weight distribution . . .

we get to location faster . . . safely"

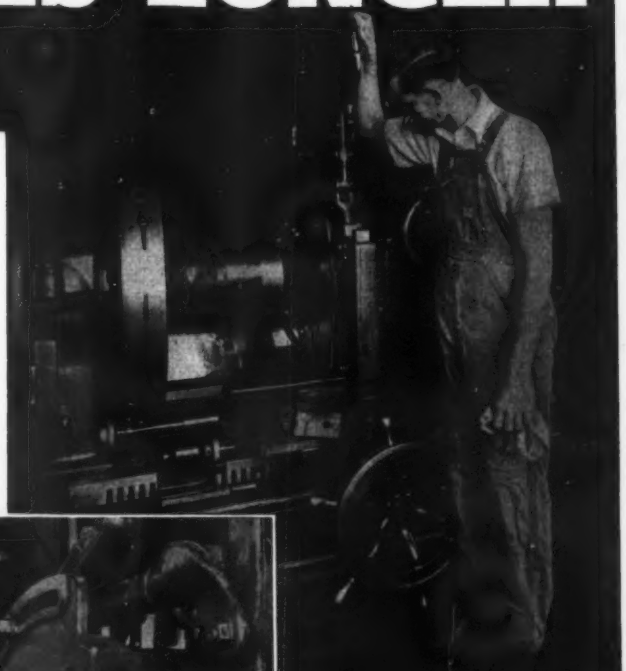
Sure, you want equipment to arrive at location *on schedule!* But, as a cost-conscious operator, you want schedules kept *without wasteful use of your equipment capital.* And that's exactly why FWD is first choice—wherever conventional trucks have roughest going and shortest life. The FWD principle of driving power on each wheel gives you many unmatched advantages. Extra traction rolls the FWD safely and swiftly over terrain that challenges ordinary vehicles. Balanced distribution of load and power minimizes strain and wear. Maintenance and "down-time" are slashed . . . creating more *productive time* and *productive dollars* for you!

GET FULL FACTS on the entire team of FWDs. Models now range from 14,500 to 58,000 GVW. 4- and 6-wheel-drives. Ask for the free "Oil Field Packet" of bulletins.

See your FWD distributor or write FWD.
THE FOUR WHEEL DRIVE AUTO CO.
Clintonville, Wisconsin
Canadian Factory: **Kitchener, Ont.**
World-Wide Sales and Service

America's Foremost Heavy-Duty Truck

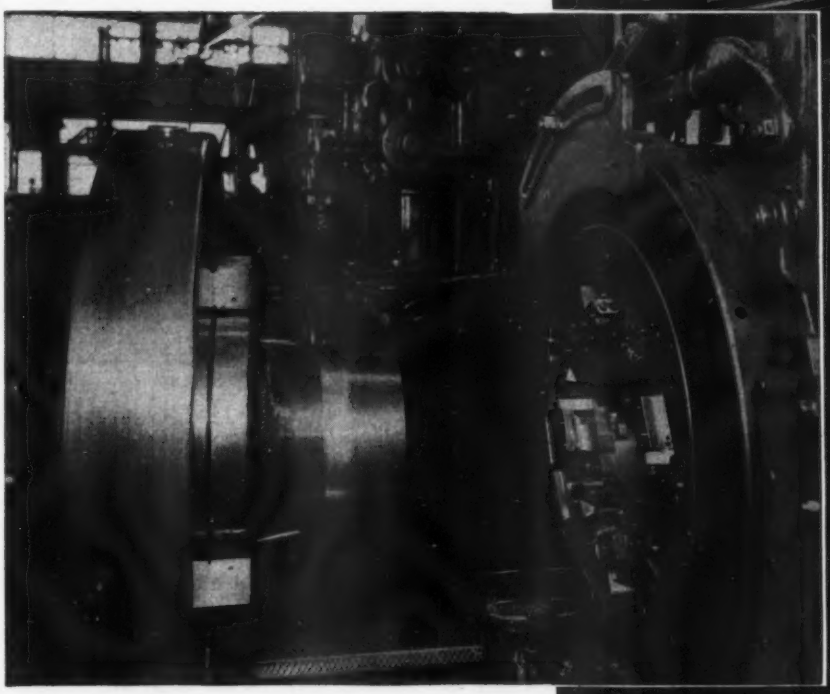
TEN TIMES LONGER DIE LIFE



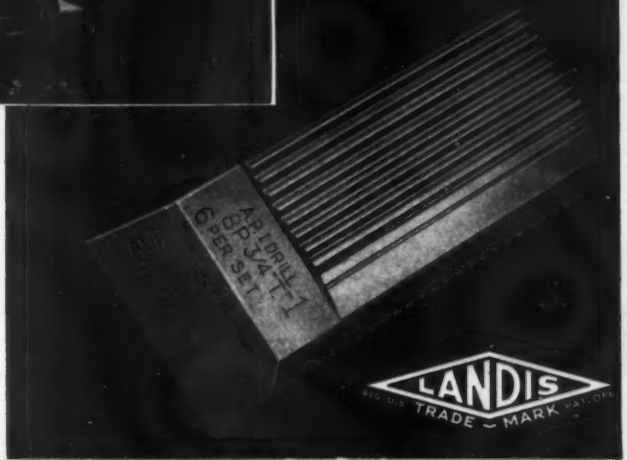
Landis Pipe Threading and Cutting Off Machines with Receding Die Heads are designed primarily for threading casing, tubing and drill pipe.

Operating at a speed of 9 R.P.M., the machine will complete an 8 Pitch 3/4" taper, 3 3/8" long thread on 10 3/4" O.D. casing in 3.21 minutes. The cutting off and bevelling time on the same diameter of casing is 4.75 minutes, while the reaming operation requires less than one minute.

Write for Bulletin No. C-77



The receding action of the die head permits the use of narrow chasers, reducing the cost 75%, less horse power is required for the threading operation, and chasers of higher hardness can be used, thus increasing the number of threads produced between grinds.



LANDIS
MACHINE COMPANY
WAYNESBORO, PA., U.S.A.

THREADING MACHINERY—THREAD CUTTING DIE HEADS—COLLAPSIBLE TAPS

Represented in the Domestic Oil Fields by: Colcord-Wright Machinery & Supply Co., St. Louis, Mo.; C. J. Harter Machinery, Houston, Texas; Frederic-Baker Co., New Orleans, La.; Moore Machinery Co., Los Angeles and San Francisco, Calif.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.

XUM

A NEW SINGLE-STAGE TURBINE DESIGNED ESPECIALLY FOR HIGH PRESSURES...

Initial pressures to 1450 psig .. Back pressures to 300 psig

THE FIRST SINGLE-STAGE TURBINE WITH ALL-LABYRINTH SHAFT SEALING

This new, high pressure single-stage turbine is more than an ordinary single-stage turbine in a "beefed up" high pressure casing. It is the *first* single-stage, mechanical drive turbine with all labyrinth shaft seals of the type generally used in large, multi-stage turbines especially designed for high pressure service.

Steam leakage along the shaft is effectively prevented by a labyrinth seal consisting of a series of shaft grooves and mating tongues of stainless steel—as many as 52 labyrinths per side being employed for the highest pressures. The labyrinth seal reduces losses, lasts longer and require less maintenance than carbon rings subject to wear.

De Laval CP Turbine for high pressure service.

When you buy a De Laval CP Turbine you also get...

True center-line support—to provide for thermal expansion without disturbing shaft alignment.

Choice of eight governing systems—to meet every control requirement.

Independent, positive over-speed trip entirely independent of the governing system for positive protection.

Horizontally split casing with steam chest in bottom half. The cover can be lifted without disturbing piping connections.

The De Laval CP Turbine is made in three sizes for capacities up to 2000 hp. For further information write for Bulletin 4215-33A-OG.

DE LAVAL

DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

T-33A

What technical service can Anaconda give you on Heat Exchangers?

ANACONDA Arsenical Admiralty Tubes being installed in tube bundle at Lemont, Illinois plant of Globe Oil & Refining Co. Fortified against dezincification by the arsenic content, tubes of this ANACONDA Alloy are being used with good results in many types of petroleum refining and other process equipment.

EVERY LARGE USER and manufacturer of heat exchangers builds up wide experience with tube and tube sheet materials. But The American Brass Company serves many such users and manufacturers, shares with each their toughest problems, makes this wider experience available to all.

Special laboratory facilities are maintained for this work. Detailed records of problems, conditions, findings are accumulated. These data, plus the results of continuous laboratory and field tests, are used to solve new problems.

These facilities can help produce the answers to your questions—suggest materials that will give your heat exchangers more dependability, longer life, more value under specific conditions.

We hope you will work with us—let us work with you. Write for Publication B-2, "ANACONDA Tubes and Plates for Condensers and Heat Exchangers." Please address The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

B0116

For efficient heat transfer ANACONDA® HEAT EXCHANGER TUBES

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SPECIFIED for Record Pipe Line!

TEAMWORK of Allis-Chalmers pumps and motors will play an important role in operation of the Transcontinental Gas Pipe Line from Brownsville, Texas, to New York City!

Fish Engineering Corp., Houston, Texas, general contractors for the 2200 mile pipe line, are using Allis-Chalmers pumping units in cold and hot jacket water systems and as utility units in compressor stations.

Throughout the petroleum industry the demand for high efficiency, low maintenance pumps has steadily increased. To serve this need, Allis-Chalmers builds pumping units engineered for specific applications. Maintenance records over a period of years prove this policy saves money and trouble for the purchaser.

You get one guarantee for the operation and efficiency of the complete unit.

Allis-Chalmers supplies pumps with capacities up to 170,000 gpm and pressures up to 2500 lbs. Special pumps are built for tough applications such as highly abrasive and corrosive liquids.

For information call your nearby A-C Sales Office or write for complete-line Bulletin 52B6059. A-3077

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Power, Electrical, Processing Equipment for Petroleum Industry

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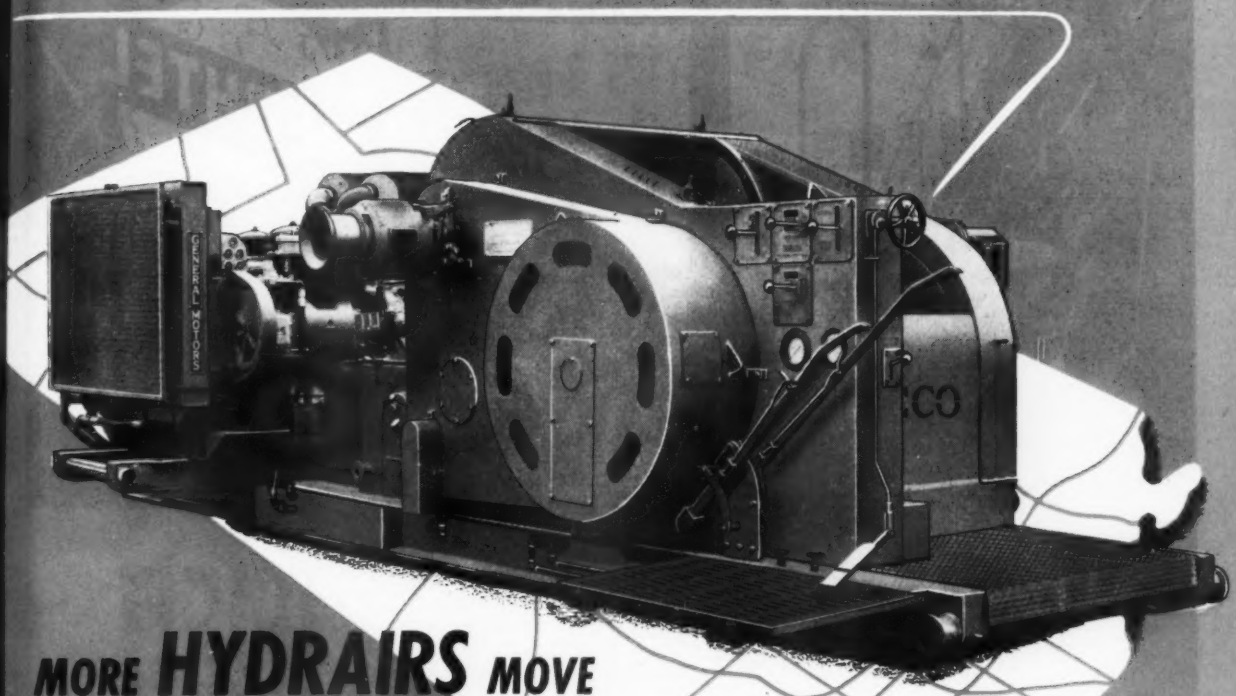

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Wherever men drill for oil the trend is to the *Hydrair Line*. This definite preference by drilling contractors has been won in the field by a record of fast, "maintenance free" operation . . . in the business office by a record of increased profit per contract.

The Hydrair Line has been designed to obtain the maximum efficiency from hydraulic torque converter drives combined with air clutches and finger-tip air controls.

Compare the Hydrair Line with competitive equipment . . . examine its "easy-to-service" design and many safety features.

There is a Hydrair Hoist designed to fill your most exacting drilling or servicing requirement. Get all the facts . . . send for Bulletin RR-48 today.

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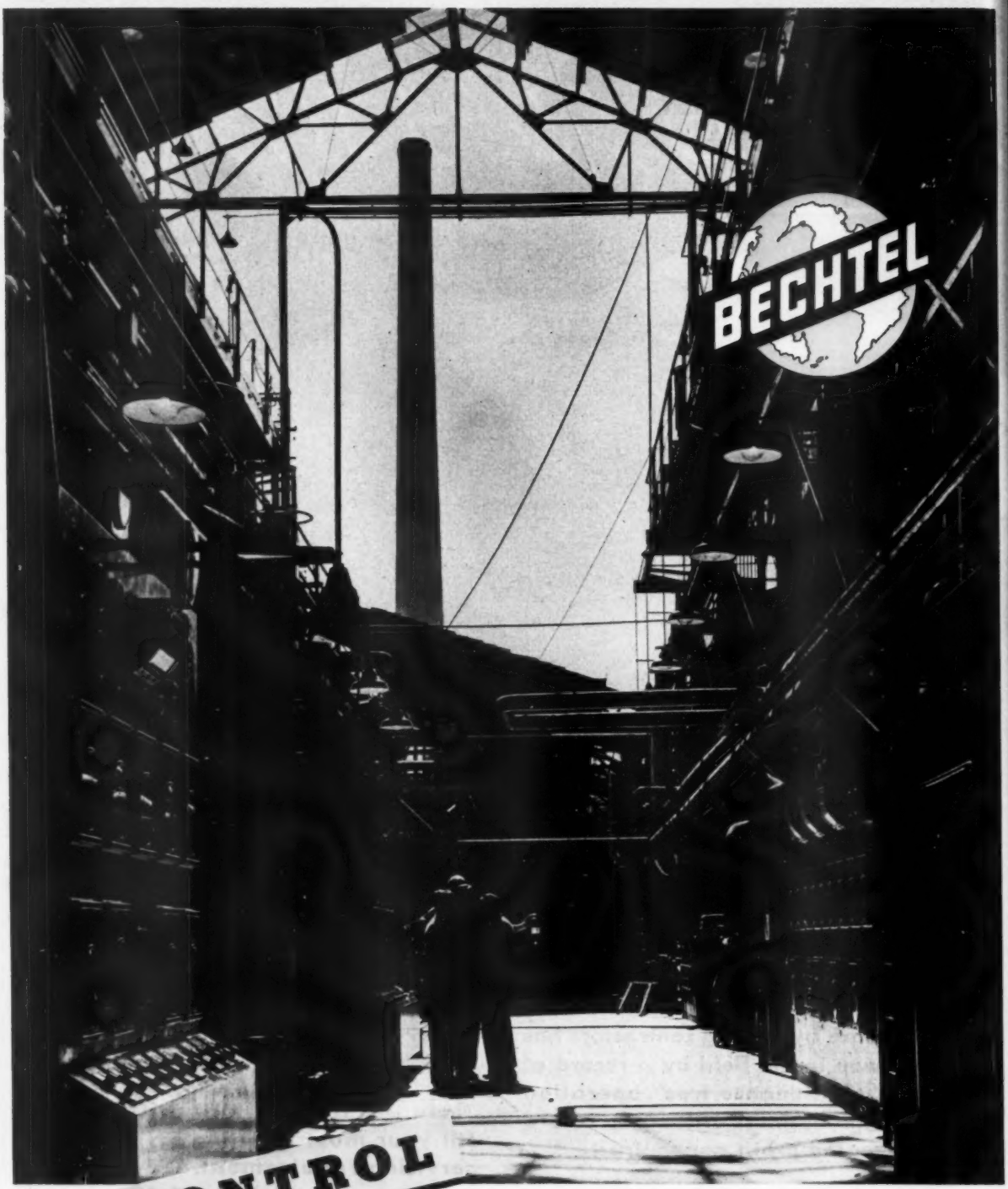

CONTROL

The all-important nerve center of a processing operation requires good design and skillful installation—a job for a seasoned organization.

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"BUILDERS FOR INDUSTRY"

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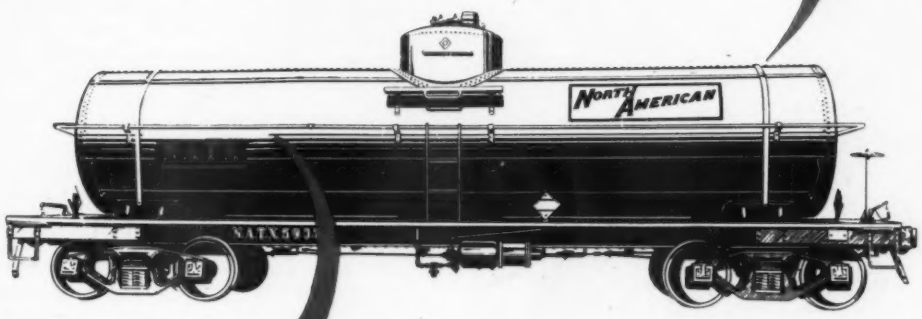
THIS SYMBOL MEANS SAFETY FOR PETROLEUM SHIPMENTS



The N.A.T.X. of North American Car Corporation identifies tank cars scientifically designed for a specific job. That's why it means safety for your petroleum shipments.

It also means extra service backed by a special knowledge of petroleum shipping problems. For North American Car plays a great daily role in the marketing of petroleum and petroleum products, a field in which it has specialized for more than forty years.

That's why so many petroleum shippers today specify N.A.T.X. . . . for special service, special knowledge, economy and safety.

For complete information on North American tank car service, call one of our offices listed below

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Choose from AIRCO'S complete line of Oxyacetylene Welding Supplies

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That's right! Whether you use a popular Airco gas welding rod, flux, or brazing alloy for production or maintenance operations . . . you're certain of top-notch work—ask any one of the thousands of welders who swear by these Airco oxyacetylene welding supplies.

This well-recognized reputation for top performance didn't just happen —more than thirty years' experience and development have gone into the manufacture of these outstanding gas welding supplies . . . know-how that produces high quality, reasonably-priced items that guarantee a job done faster, done better, done easier and done at less net cost.

For further information about Airco's oxyacetylene welding supplies which includes a complete line of rods, fluxes and brazing alloys, write your nearest Airco Office or Authorized Dealer for a free copy of Catalog 12.

More news about AIRCO products

AIRCO No. 1 ALLOY STEEL

A Smooth-Flowing, High Ductile Rod Insuring Good Control of Molten Pool

This rod (AWS Classification GA60) is ideal for welding low carbon and low alloy steels, including pipe of grades A and B analysis. Outstanding among its many important features is the high ductility in the "as welded" condition. Because of its mechanical properties, this rod is desirable when undertaking qualification tests like those included in The American Standards Association Code for Pressure Piping. It is smooth flowing, insuring good control of the molten pool, and, in addition, will withstand considerable heating without burning.

PHOS COPPER

A High Standard Copper And Phosphorous Brazing Alloy

It is self-fluxing when used on copper-to-copper joints but requires a good low melting point flux when brazing brass, bronze or other alloys. It is completely fluid at approximately 1382°F. at which temperature best results are secured and is used in the manufacture of electrical, refrigeration and air conditioning equipment. Available in rod and strip form.

AIRCO MARVEL BRAZING FLUX

A High Quality Flux That Remains Molten And Viscous Over A Wide Temperature Range

It is a uniformly high-quality flux for use in braze welding cast iron, malleable iron, copper and steel and for welding brass, bronze and copper. Marvel Flux remains molten and viscous over a wide temperature range. Its use protects the weld metal from oxidation and effectively reduces or removes oxides and other foreign matter. Marvel Flux is a general purpose flux for the welding shop.

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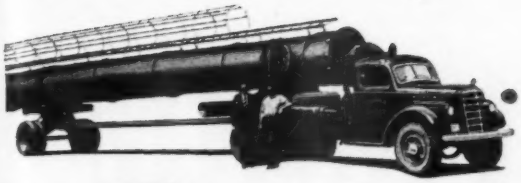

...Cut Down "TRUCK ABSENTEEISM"

put MACK TRUCKS on your job

"Truck Absenteeism," like its human counterpart, disrupts the efficiency of your business . . . adds materially to your costs. Actual job records prove that with Mack trucks on the job "truck absenteeism" is reduced to an absolute minimum. That's because Mack trucks have built-in durability . . . extra reserves of strength and stamina. Because they're better built, they're better able to stand up to the demands of hard-working, day-in, day-out service. Work done on the job will always be the one true yardstick of truck value. Figured that way, every Mack truck gives full measure — and more — in round-the-clock dependability; longer, more trouble-free mileage life; sustained earning power; and rock-bottom maintenance costs.

On the job — and on the job records — it proves out every time: "YOU GET MORE WORK *OUT* OF MACK TRUCKS, BECAUSE MORE WORK GOES *INTO* MACK TRUCKS."

BE PROFIT-WISE

modernize with

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...outlasts them all!

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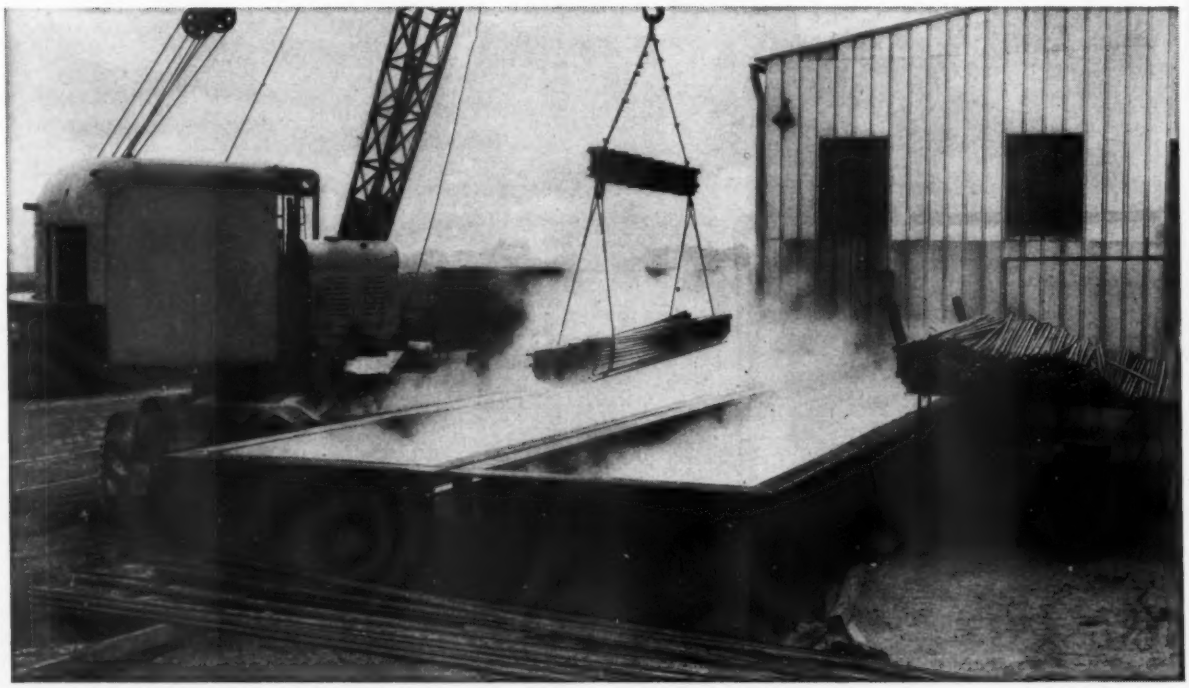
Mack Trucks, Inc., Empire State Building, New York 1, New York. Factories at Allentown, Pa.; Plainfield, N. J.; New Brunswick, N. J.; Long Island City, N. Y. Factory branches and distributors in all principal cities for service and parts. In Canada: Mack Trucks of Canada, Ltd.

Watching pipe protection costs?

First cost often doesn't tell the whole story! It omits the *major* expense of too many pipe-protection jobs—the cost of maintenance. That is why today's corrosion engineers insist on investigating *every stage* of a protection process before placing a job. They have learned that the *life* of the pipe—the years it can resist every corrosive agent—depends upon how soundly the pipe is conditioned and how scientifically the protection is applied.



WHAT'S HAPPENING HERE is just the first step in Hill, Hubbell's exclusive *controlled* process of pipe protection. Bare pipe is dipped in hot caustic solution to remove every trace of cutting oil and grease. Then it is rinsed in clean hot water, ready for the drying oven and the Hill, Hubbell-engineered Roto-Grit-Blast cleaning and etching machine.

Only this kind of conditioning can prepare pipe for *positive* bonding of the protective layers. And only the skillful *factory* application of these layers can assure the long-range service that keeps protection costs low.

Hill, Hubbell and Company

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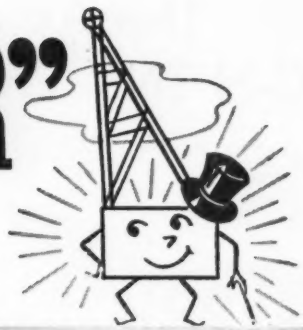
Headquarters: 3091 Mayfield Road, Cleveland 18, Ohio

For a Quarter Century the Pioneer in Pipe Protection

"MR. SPUDDER"



Since 1940

Since the first Bucyrus-Erie 36-L spudder was introduced in 1940, this highly mobile, easy-to-rig machine has become "Mr. Spudder" in oil fields everywhere. That's because the 36-L delivers fast, low-cost performance on top-to-bottom drilling to 3500 feet, on tailing-in behind rotaries, and on cleaning-out, repairing, and other servicing operations to much greater depths. Look over the sample features listed below . . . they'll show you why the 36-L can make money for you:

1. Fast hoisting speeds on all reels permit quick handling of tools, bailer, and casing.
2. Two forward speeds and instantaneous reverse on all drums give the split-second control needed for diversified work.
3. Snappy spudding action, with shock absorber that can be blocked out for deep drilling, means real drilling speed even in tough formations.
4. Automatic spooling device means longer cable life, fewer delays, reduced operating expenses.
5. Power operated derrick hoist means speedy rigging up, enables you to raise or lower derrick in a matter of minutes.
6. Operating levers, conveniently grouped at the operator's station, enable the driller to be on top of the job at all times.
7. All-steel, 54-ft. telescoping derrick, with casing tackle strut, has capacity for 75,000 pounds static load; with auxiliary derrick leg, 112,000 pounds.

If your depth requirements are above or below 36-L ratings, investigate these field-proven, time-tested companion models: 48-L for drilling to 6000 feet, servicing to 7000 feet; 28-L for drilling to 2500 feet, servicing to 3000 feet; 24-L for drilling to 1500 feet, servicing to 2000 feet. See your nearest Bucyrus-Erie spudder distributor for complete information.

72590

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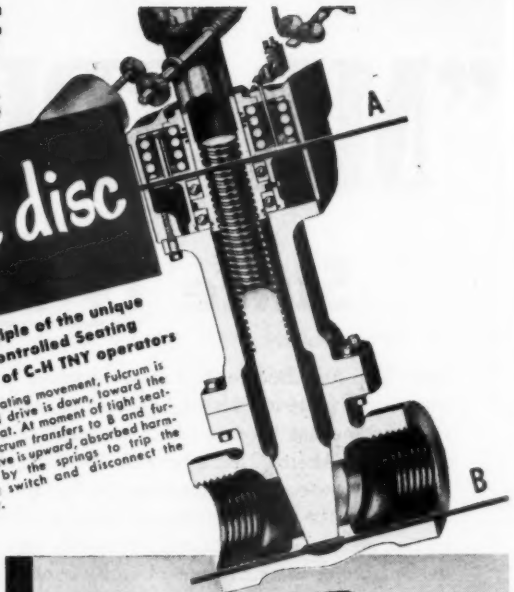
The Amazing Story of C-H TNY Valve Operators

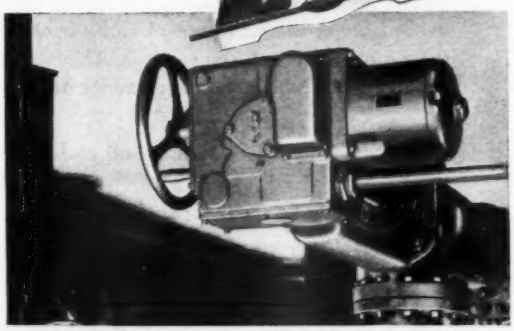
Positive seating of valve disc

...but without damage to valve parts



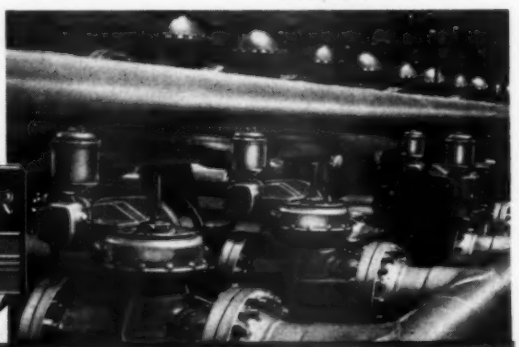
The principle of the unique Thrust Controlled Seating feature of C-H TNY operators

During seating movement, Fulcrum is at A and drive is down, toward the valve seat. At moment of tight seating, Fulcrum transfers to B and further drive is upward, absorbed harmlessly by the springs to trip the Thrust switch and disconnect the motor.



(Above) Experience behind C-H Type TNY operators dates back to 1900, embraces every type of valve application.

(Below) For valves which do not seat such as plug type valves, C-H B2 automatic declutching valve operators act swiftly and stop instantly.



Cutler-Hammer Motorized Valve Operators not only provide the automatic, immediate and swift operation of valves but they also assure *accurate* seating, *safely*.

Due to the exclusive *Thrust Control* principle employed, these operators provide the following important advantages:

They *always* assure a tightly seated valve regardless of the frictional condition of the valve stem or the driving mechanism.

They *definitely* prevent damage to a valve from the expansion and contraction of valve parts under extremes of temperature.

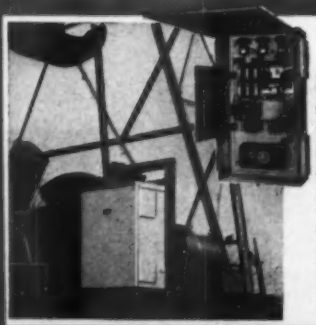
They *unfailingly* provide accurate seating no matter how swiftly the valve is closed and they prevent damage in case foreign matter lodges in the valve.

Cutler-Hammer *controlled thrust* Valve Operators gain their superiority through what may be called a transferable fulcrum. They drive through a yoke nut fulcrum established by heavy steel springs whose compression is equal to the desired tight seating pressure. When the valve is accurately seated, the *seat* becomes the fulcrum, the yoke nut retracts, opening the motor circuit, and motor drift is absorbed by the springs. Moreover, the same accurate seating is maintained as valve parts expand and contract.

Now is the time to investigate this proven superior motorized valve operator for your needs. Available as standard equipment on all leading makes of valves . . . CUTLER-HAMMER, Inc., 1453 St. Paul Avenue, Milwaukee 1, Wisconsin.

CUTLER-HAMMER
VALVE CONTROL
C-H

Other Cutler-Hammer Products for the Oil and Gas Industry

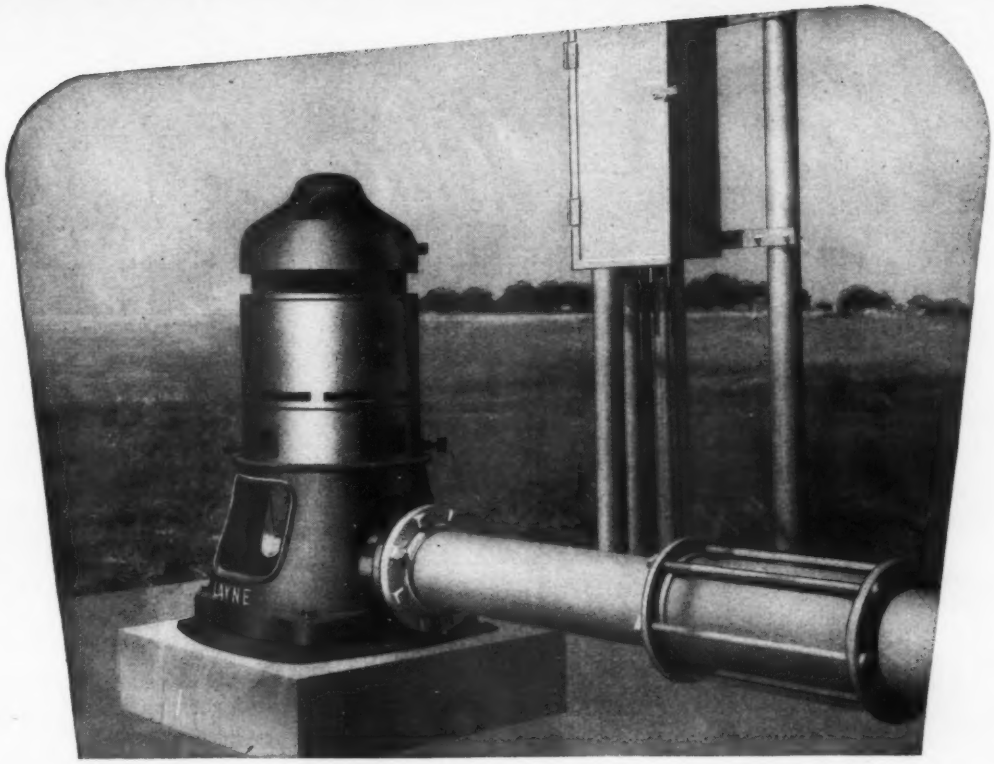


Long-lasting control that "schedules" oil well pumping

This Cutler-Hammer Motor Control Device built to the rigid requirements of tough oil country service automatically starts pump going and shuts it down in synchronization with oil well capacity or in conformity to operating schedule. You can set up any sequence of day and night operation, set it to skip certain days. Bulletin 9589D-21 tells all about this amazing pumping control. Send for free copy.

Know what you are buying, selling, giving away *These "gas counting" instruments tell you accurately*

Cutler-Hammer Calorimeters . . . standard wherever gas is bought or sold—actually count the B.t.u.'s per cubic foot of the gas you are sending or receiving. Accurate within 1%. They also write a continuous 24-hour a day permanent record so you know at all times exactly what is going through your piping system . . . for accurate accounting and billing, and for accurate control of gas heating value. Free booklet "Where Experience Counts" tells all about C-H B.t.u. Control.



For Lasting Quality Here Is America's Top Value

If your requirements call for a Well Water System of utmost dependability, and one that must serve for a long period of years with little or no upkeep expense, you are urged to check the features of those built by Layne. The experience of nearly seventy-five years has gone into their design and construction. With thousands of installations scattered throughout the world, Layne has had an unmatched opportunity to find, correct and greatly strengthen every possible weak point of construction. Constant improvement of design has made them the world's most efficient.

You can also be sure of lasting quality! Extensive research for, and the use of the most suitable metals for all parts has given these famous well water systems an extraordinarily long life under all conditions. Feature for feature, Layne Well Water Systems are acknowledged to be the world's finest. No experienced engineer will question that statement.

Layne will gladly, without obligation, give helpful information on any water supply problem. For further information, literature, etc., address

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GENERAL OFFICES, MEMPHIS 8, TENN.

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LAYNE

WELL WATER SYSTEMS

VERTICAL TURBINE PUMPS

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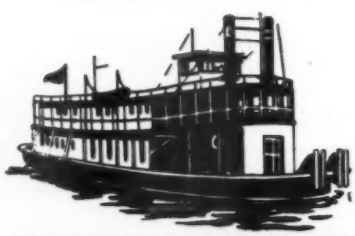

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Call Avondale!

Tomorrow, the next day — who knows when? You may suddenly have need for expert repair or construction. In such case, call experts — call AVONDALE . . . all types of marine work for the oil industry.

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AVONDALE MARINE WAYS, INC.

RIVER FRONT, MAILING ADDRESS: NEW ORLEANS DISTRICT WESTWEGO, LOUISIANA

MAIN PLANT: AVONDALE, LA.
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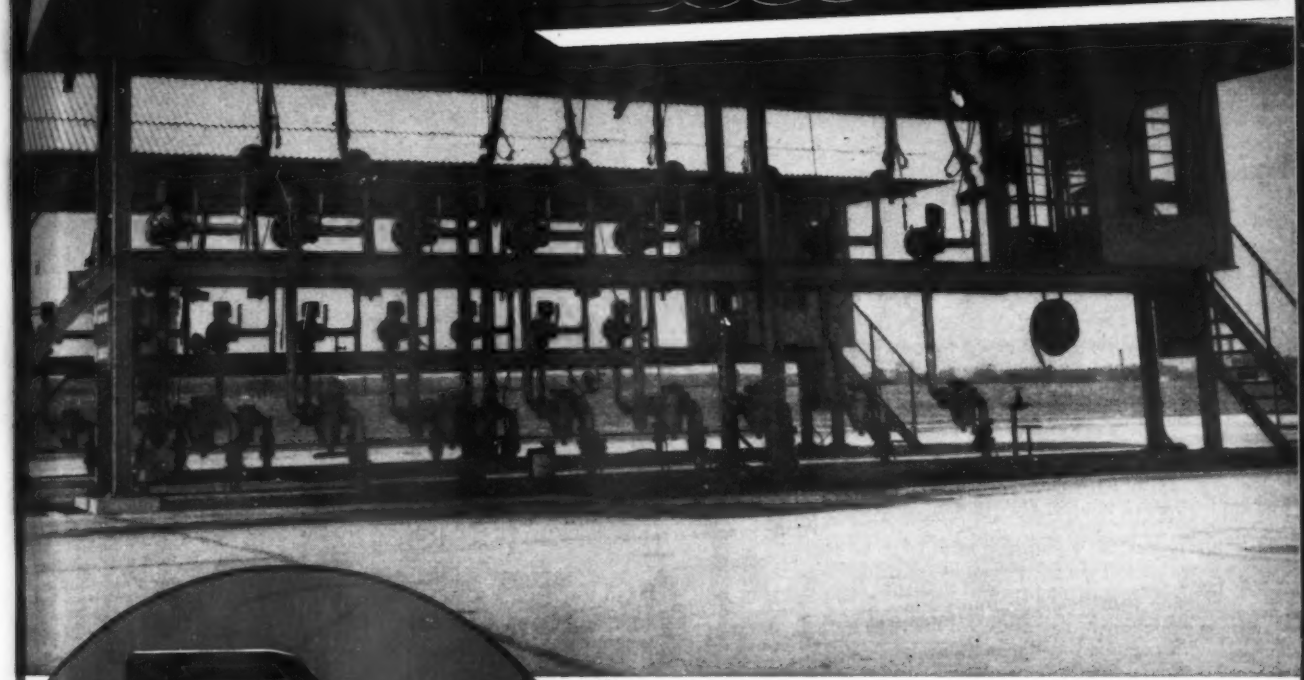
SINCLAIR

OIL CORPORATION'S

New Twin Rack

IN PHILADELPHIA
EQUIPPED WITH

16 ROTOCYCLE METERS



Model B-5 Rotocycle with printing register. Capacity 500 gpm on pump. Other sizes having pumping capacities of 100, 200 and 350 gpm available.

Where experience wrote the specifications

The selection of Pittsburgh Rotocycle meters by the Sinclair Refining Company for its new twin loading rack at the Philadelphia Terminal was a tribute to the accuracy and proven dependability of this equipment. There are a total of 16 Model B-5 Rotocycles with printing registers installed on these racks; eight to each platform.

Previous experience with Rotocyle meters at other Sinclair terminals and bulk stations dictated the meter choice. Repeat orders *are* the best evidence of satisfaction and every day old customers are ordering more Rotocycles. We would like to demonstrate why—show you some interesting case histories of actual operating experience. Write today.

Pittsburgh Equitable Meter Division

ROCKWELL MANUFACTURING COMPANY

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ONE is always Outstanding!

In August of 1881, the Casino at Newport, R. I. was the scene of the first national singles championship of the U. S. Lawn Tennis Association. Since then, the greatest names in tennis have battled for this highly prized title.

The carefully conditioned stamina of tennis stars is a determining factor in championship performance. So, too, is the endurance built into Jones sucker rods.

Starting with steels, to Jones specifications, these rods are made to highest standards. Special forging practice assures freedom from early, expensive failures. Controlled full length normalizing produces a strain-relieved, fine-grained structure. Shot peening adds strength—increases resistance to fatigue failure. Precision threading assures strong, enduring, tight fitting joints. Even the distinctive green paint offers extra protection against corrosive forces.

Add to this more than fifty years specialized experience in making and fitting rods to every pumping condition and the preference for Jones sucker rods is readily understandable. Write for our latest catalog.

THE S. M. JONES COMPANY
(Subsidiary of Buffalo Bolt Company)
General Office and Factory: TOLEDO, OHIO
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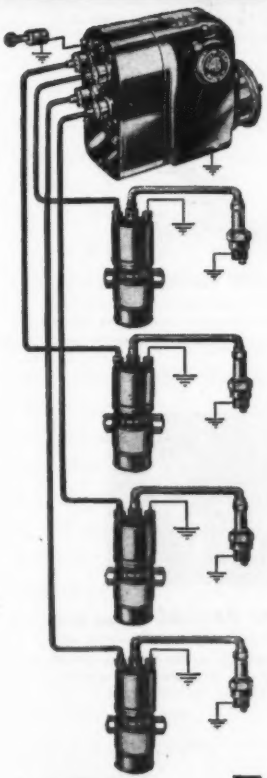
50 Church Street, N. Y. C.

The Best by Any Test!



A NEW LOW TENSION MAGNETO IGNITION SYSTEM FOR LARGE, SPARK IGNITED ENGINES!

The System comprises the new American Bosch MRB Low Tension, shielded Magneto with individual High Tension Ignition Transformers mounted at each engine cylinder (as shown in diagram of 4-cylinder installation at left). Low tension current, generated in the Magneto, is distributed through low tension leads to the Transformers where the electrical energy is converted to high voltage and conducted to the spark plugs by short cables—shielded if desired. The rugged, heavy-duty high tension Transformers are available with or without shielding (as illustrated) to suit specific installation needs, either in use in the new American Bosch Low Tension Magneto System or other low tension systems employing magneto or battery ignition.

Energy losses and corona effects which occur with long high tension cables are eliminated in this new, versatile Low Tension System. The possibility of fire and explosion hazard is minimized where engines operate in combustible oil or gas vapors . . . radio and television interference may be greatly reduced by complete shielding. These important operating advantages, combined with the outstanding electrical and mechanical features of the new American Bosch Low Tension Magneto offer maximum spark efficiency under the severest conditions for your large bore stationary engines. Write for the facts and we'll show you how you can get this high standard of performance and safer, continuous operation on your present equipment.

American Bosch

MAGNETOS • GENERATORS • VOLTAGE REGULATORS • IGNITION COILS
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THESE EDWARD DESIGN FEATURES

ALL ARE "FIRSTS"... MANY ARE "EXCLUSIVES" ...EACH MEANS A BETTER VALVE

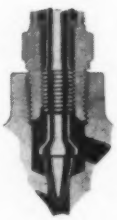
INCLINED STEM VALVES First to build inclined stem forged globe stop valves and check valves. Edward construction eliminates turbulence, cuts wear, reduces pressure drop 25 to 50 per cent.

RADIUS STEM HEADS Radius of stem head assures application of closing load at center of disk. Curvature of inside of disk, in contact with stem head, centers disk for sure, tight seating.

FOOLPROOF STEM BACKSEATS Spherical stem or disk nut surface contacts taper bonnet surface to make a pressure-tight backseat. Exclusive with Edward.

UNIVALVE* BONNET JOINT Patented leak-proof welded body-bonnet joint assures perfect alignment of working parts, permits disassembly if ever necessary.

EVALIZING* Exclusive Edward process electroplates parts with wear-resistant metallic lubricous material. Reduces wear and friction between internal valve parts 50 per cent or more. Ideal for temperature service.



TAPER THREAD BONNET JOINT Taper threaded joint in small forged gage valves gives tight seal, withstands extreme pressures.

CROSS ARM IMPACTOR* HANDWHEEL Now the famous Edward Impactor principle is applied to small valves. Easy-to-grip cross-bar delivers 2.8 times the closing load of ordinary handwheels. No wrenches or extensions needed.

FORGED STEEL FLANGED VALVE DESIGN Edward designed first forged valves with symmetrical, uniform wall thickness. Eliminates thermal distortion and stress, cuts needless weight.

SWING BOLT RETAINER New type retainers keep packing gland swing bolts in place on integral forged support pins, yet out of way for easy repacking.

NO-BONNET INSTRUMENT VALVE No chance for bonnet joint leak with these compact all forged valves for toughest instrument line service.

WELDED-ON FLANGES Edward patented first valve constructions using welded flanges. Permits super strong drop forged bodies with thin walls and proper fibre flow.

EVALPAK* PACKING Edward developed first asbestos-graphite packing with special processing to prevent stem pitting. Die molded, wire supported, low operating torque.

OTHER EDWARD FIRSTS! **Patented EValthrust* yoke bushings . . . Impactor* handwheels . . . Closure indicators . . . Low pressure loss cast steel body contours . . . Three-point disk guiding . . . Self-centering disk throttling lip . . . Free floating tubular disk-piston . . . Edward Equalizer* . . . Edward pressure-seal design . . . Intex* integral seats . . . Seat-located guide ribs in gate valves . . . Hour-glass type disk-piston . . . Separated feedline stop-check valves . . . Patented interchangeability of stop, check and non-return valves.**

**Registered trade name of Edward Valves, Inc.*

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assure top FORGED STEEL VALVE VALUE

ON'T SETTLE FOR LESS!

Forged Steel valves, because they are small, sometimes don't get the attention they deserve when specifications are drawn.

But the smallest valves, if not equal to the service to which subjected, may be the most troublesome. Therefore, it pays to take the time to analyze design features and to study actual service records.

If you do, you'll find that Edward forged steel valves are the most copied in the field. You'll find that dozens of features that were Edward "firsts" are now accepted as industry standards. But you'll also find that there are still many patented features exclusive with Edward.

Edward pioneered *forged steel* valve construction, and Edward design developments have consistently been a step ahead of mounting service requirements, piling up outstanding service records in some of America's most famous power plants and process installations.

Don't discount experience. For steel valves for pressures from 150 to 7500 lb, expect the best ***first*** from Edward.

Edward

New design Fig. 444-448 series *all forged steel* globe and angle valves, 600 and 1500 lb sp, bolted or union bonnets, screwed or welding ends. Fig. 444 illustrated.

Edward

All forged steel welded bonnet Univalves®, 1500 and 2500 lb sp. Integral Stellited seat, Stellited disk, chrome-moly bodies, with permanent or removable backseats for disassembly in the line. Fig. 2224 illustrated.

Another Product

Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

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EDWARD VALVES, INC.
1492 West 145th Street, East Chicago, Indiana

Please send me Bulletins describing Edward forged and cast steel valves.

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☐ Have Edward representative call.

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Achieves the long-sought V-BELT DRIVE for LOOMS

For Cotton Mills and Rayon Mills

Loom operators had long *wanted* a V-Belt Drive for their looms. *But*—

Stubborn Difficulties

—stood in the way. Gates over-came these difficulties through SPECIALIZED research in the world's largest V-Belt testing laboratories, thus providing—

Another Accomplishment For Industry

by Gates SPECIALIZED Research

THE extremely small diameter of pulleys over which loom drive V-Belts must flex under severe shock-loads posed a problem in V-Belt construction that seemed *insurmountable.*

But, with war-born synthetic fibers of unusual strength; and with man-made rubbers possessing engineering properties never available before—and with the great research and testing facilities available at Gates—a V-Belt was achieved that met the rigorous conditions of loom drive operation.

Then, a clutch of very advanced design was wanted—a clutch that would do *more,* with *less* maintenance, and *fewer* troublesome adjustments than the clutches commonly used with gear and pinion drives on looms.

Gates therefore engineered a clutch that is a marked improvement over the clutches previously available for looms.

Finally—and this was most important, too—the entire drive assembly had to be so designed that it would go on the loom without any costly re-arrangement of existing mill equipment. This rather demanding job of design was also accomplished.

Today, the Gates V-Belt Drive for looms is cutting operating costs—and giving bigger loom output with better quality of cloth—in Cotton Mills and Rayon Mills the country over—another accomplishment of Gates SPECIALIZED Research!

ENG-505

THE GATES RUBBER COMPANY
The World's Largest Makers of V-Belts
DENVER, U.S.A.

GATES VULCO ROPE DRIVES
Engineering Offices and Jobber Stocks IN ALL INDUSTRIAL CENTERS of the U. S. and 71 Foreign Countries

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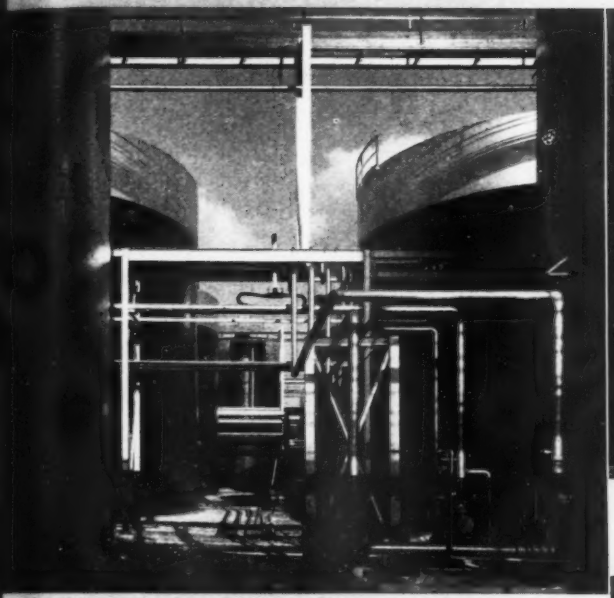
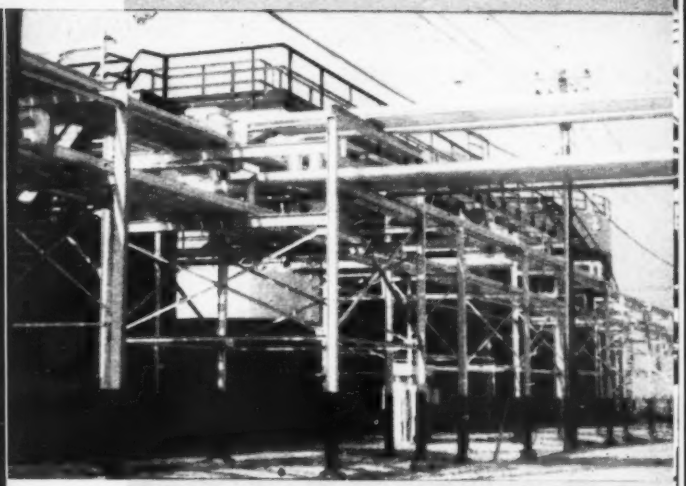
ELLERBEE BROTHERS



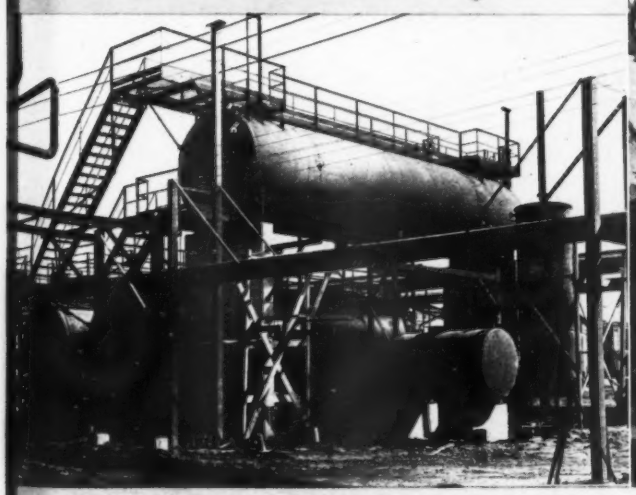
42' 6" x 40' 10,000 barrel welded tanks erected for a Gulf Coast oil refiner.

Three 10' x 40' vessels were erected intact on this job.



The piping and overhead stanchions and walkways were erected for a major Gulf Coast refiner.

Structural steel framework of this traveling feed hopper was erected for Texas Gulf Sulphur Company.



For more than 20 years, members of the Ellerbee Brothers organization have worked with structural steel and erection of tanks. Since the Ellerbee Brothers organization was formed, they have used their rich back-log of experience in completing contracts for most of the major oil and chemical companies on the Gulf Coast.

Personal supervision . . . and personal pride in each job . . . adds the finishing touch to every Ellerbee Brothers job. Write for the Ellerbee Brothers brochure. It gives a complete background on the organization.

ELLERBEE BROTHERS

P. O. BOX 857 PORT ARTHUR, TEXAS

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KNOCKOUT NEWS!

IT'S NEW!
IT'S 110 VOLT!
IT'S PORTABLE!

No other unit under $1,400 approaches its sensitivity and convenience!

It's genuine Magnaflux—by the pioneers and originators of magnetic particle inspection!

It locates not only surface but subsurface defects!

Its magnetizing current is both AC and DC from 110 Volt AC line!

It magnetizes any *shape* with wrap-around cables 30' long!

New MAGNAFLUX* INSPECTION UNIT *for* OIL TOOLS

It's $485 COMPLETE!

with instructions and equipment for dry powder magnetic particle inspection

HERE is the logical outcome of 20 years spent by Magnaflux developing magnetic particle inspection—the new Magnaflux KH-05 specially designed for you—for inspection of drill collars, kellys, and other drilling tools and machinery, anywhere within reach of a 110 volt convenience outlet. It offers drilling contractors huge tool savings!

We can't begin to list all the features on this page—such as the full day of personal instruction by a Magnaflux Field Engineer, the license to use this unit under certain Magnaflux patents,—*all included* in this amazing low price!

There are too many remarkable features to explain here. They're too important to miss. Write and register yourself to receive the bulletin now being rushed by the printer. Write today.

Accessories include 3 magnetizing cables with either-end connectors carried on hooks at rear, Magnaflux dry powder and bulb in accessory compartment. Set of prods, illustrated at left is an optional extra,—also a full Magnaglo kit can be used with the KH-05.

*Magnaflux and Magnaglo are U. S. Registered, trademarks of Magnaflux Corporation.

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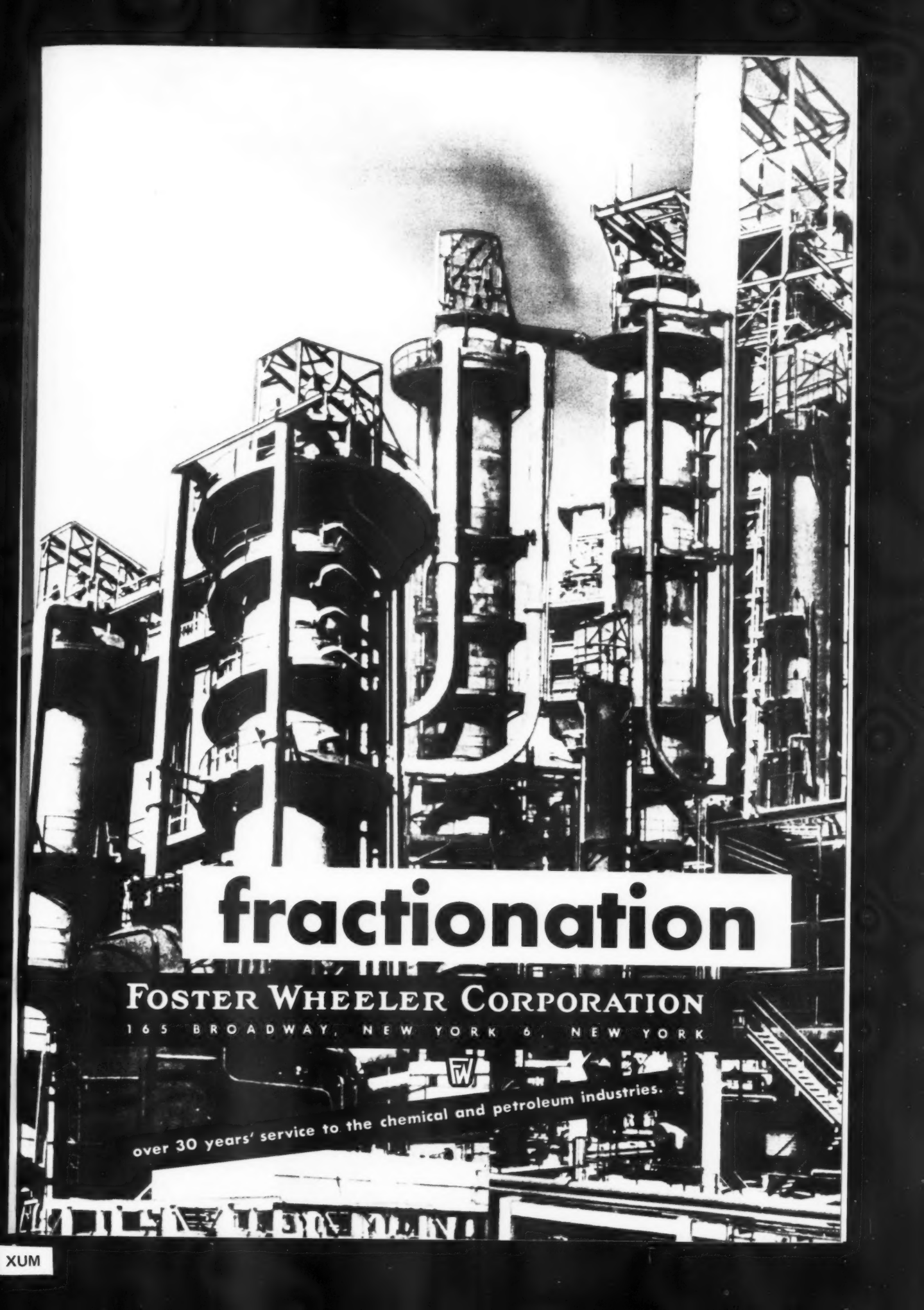
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over 30 years' service to the chemical and petroleum industries.

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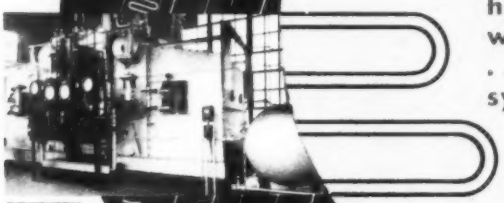

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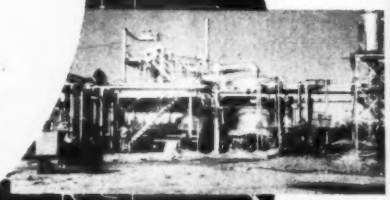
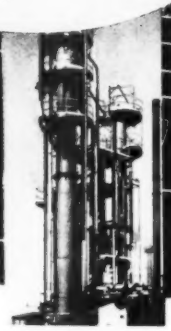


SULFUR RECOVERY



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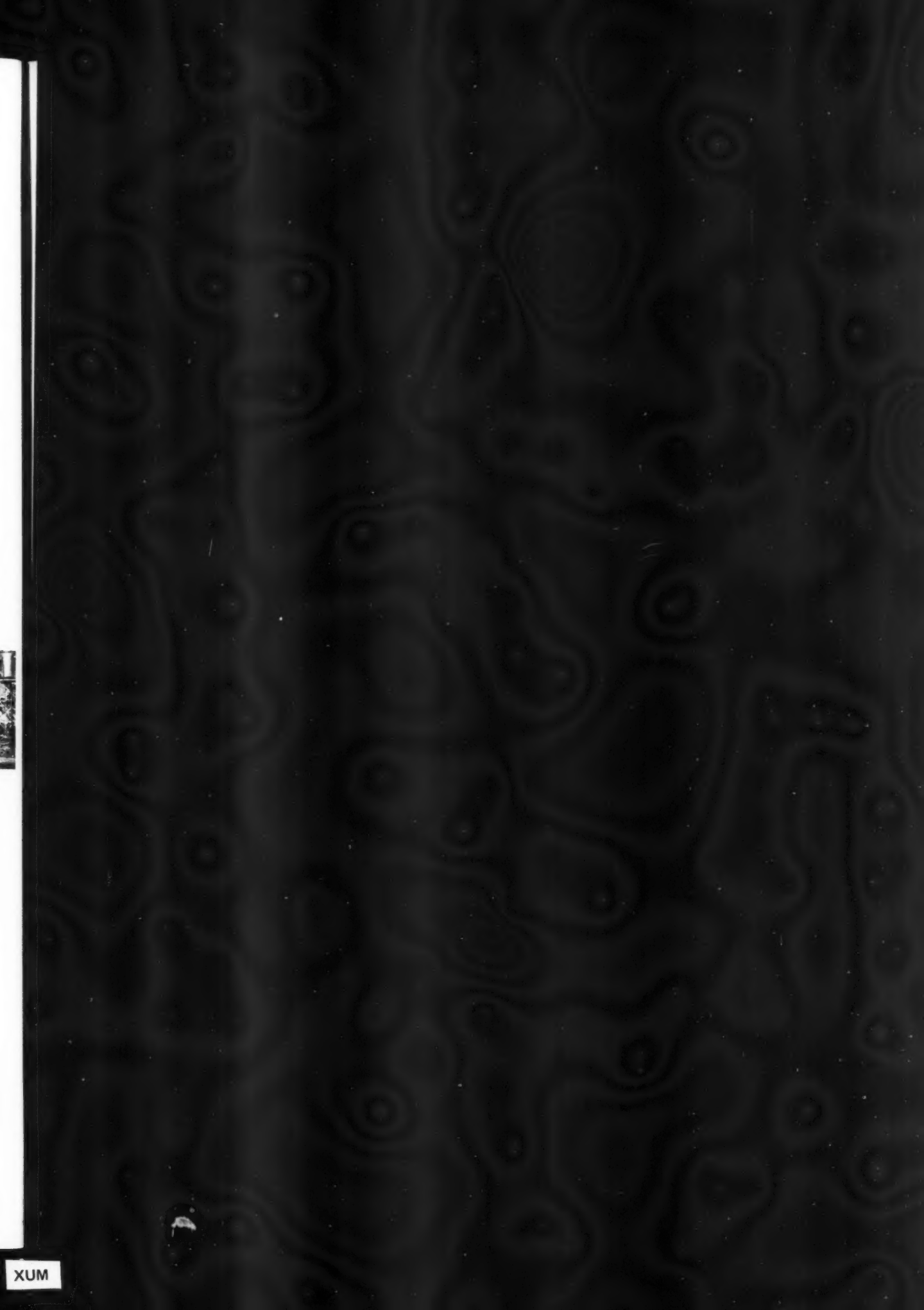

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How to keep a drill team from marking time

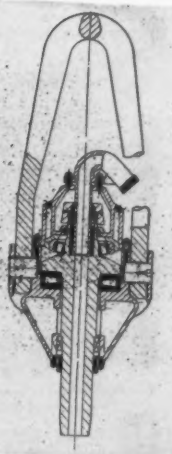
TO give you a faster, more economical drilling team, The Brewster Company, Inc. equips its rotaries, swivels, blocks and drawworks with Timken® tapered roller bearings.

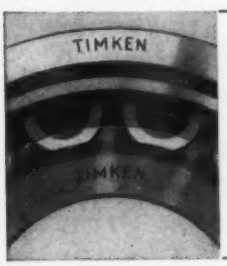
Because of the line contact between the rollers and races, Timken bearings give extra-load carrying capacity. True rolling motion and the incredibly smooth surface finish of the rolls and races practically eliminate friction and wear. Equipment lasts longer, spends more time on the job—less time under repair. And Timken bearings require less attention for lubrication, saving both time and lubricant.

Made of the best steel ever developed for tapered roller bearings—Timken fine alloy steel—Timken bearings normally last the life of the equipment in which they are used. Make sure you have them in all the drilling equipment you buy or build. Look for the trademark "Timken" on the bearings. The Timken Roller Bearing Company, Canton 6, O. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best

THE BREWSTER COMPANY, INC. *uses Timken tapered roller bearings in its swivels to carry the heavy loads, reduce friction and keep maintenance to a minimum.*





POSITIVE ROLLER ALIGNMENT

Wide area contact between roll ends and rib of the cone prevent Timken rollers from skewing. Result: bearings roll easier, last longer.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. special analysis steels.

TIMKEN

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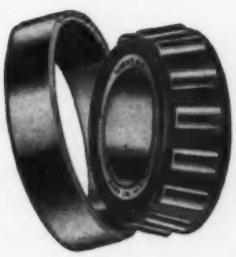
TAPERED ROLLER BEARINGS



NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL AND THRUST →◫← LOADS OR ANY COMBINATION

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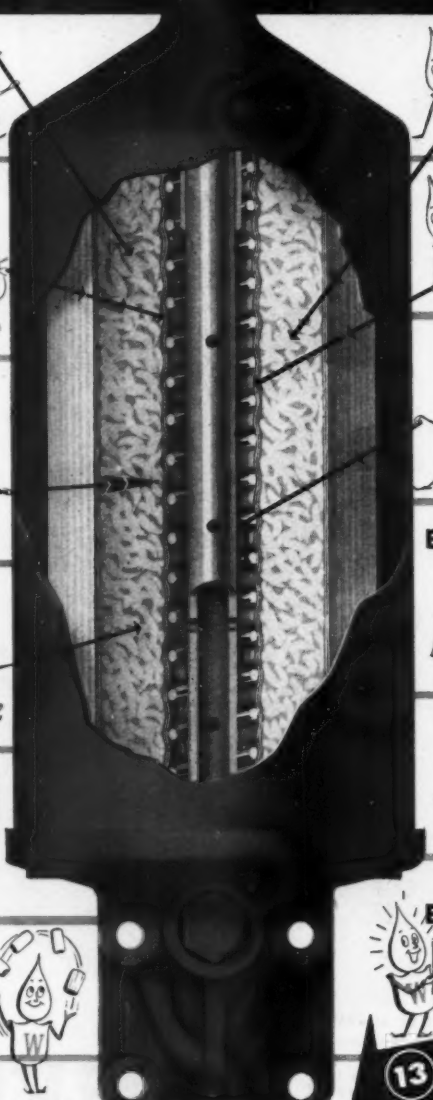
13 is your lucky number

ONLY WHEN YOU PROTECT YOUR ENGINE WITH

WINSLOW FILTERS



1 REMOVE ACIDS by special neutralizing agents.

2 STOP MOISTURE at water-repellent surface, absorb residue in element fibers.

3 TRIPLE SAFETY Patented rupture-proof double covering; element materials harmless to engine; additives unchanged in compounded oils.

4 TRAP ABRASIVES such as gritty carbon, dust, or metal particles.

5 TOP EFFICIENCY Channels narrow toward center, stop larger particles first, smaller ones later, hold them *all*.

6 FREE FLOW Entire outside surface filters oil; spring coil core maintains free flow.

7 LONGER LIFE Element fibers absorb impurities, straighten out, keep channels open for longer use.

8 ELEMENTS HOLD DIRT twice, triple, quadruple their original weight.

9 RIGHT SIZE Winslow Filters for all sizes of engines.

10 FULL-FLOW Filters *all* the oil oftener, cleaner.

11 ELEMENTS FOR ALL standard makes of filters.

12 ENGINEERING SERVICE to meet special filtration problems.

13 DISTRIBUTORS AND DEALERS throughout the United States, Canada, in foreign nations, offer convenient service.

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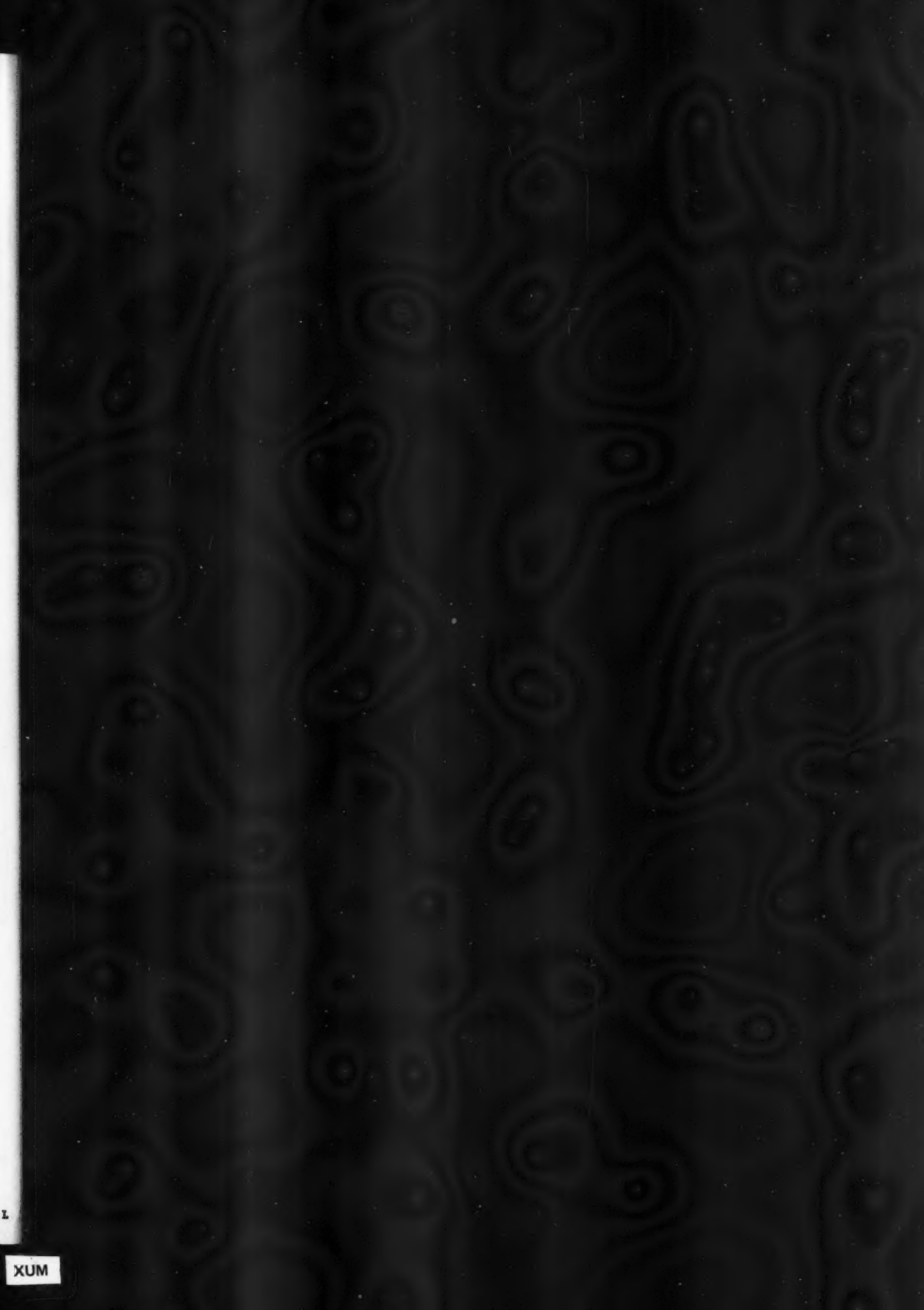

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PRECISION SEISMIC SURVEYS

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REFRACTION

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SOUTHERN GEOPHYSICAL COMPANY

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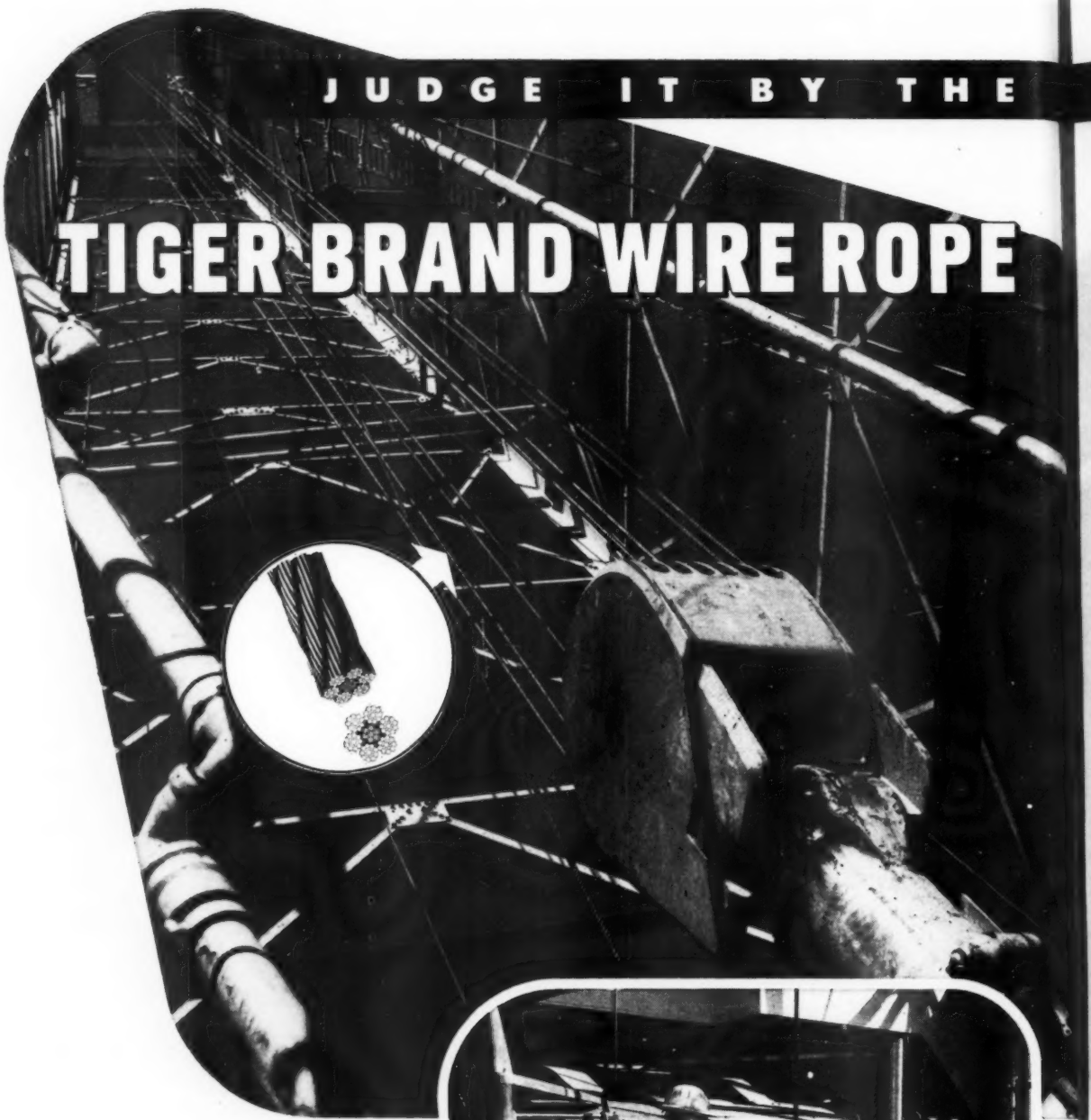
JUDGE IT BY THE J

TIGER BRAND WIRE ROPE O



PLENTY OF STRENGTH to lift the heaviest loads with this Tiger Brand 6 x 19, 1¼" line with wire core. This type of line has high resistance to crushing and gives extremely long service.

FASTER ROUND TRIPS are possible with smooth running Tiger Brand Preformed Lines strung with only 8 lines in the blocks instead of 12.

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UNITED STATES STEEL

ON THE "LAGUNA MADRE"

—new off-shore drilling barge—

● The "Laguna Madre" is one of the most modern drilling barges in existence today. It was specially designed for the rugged service in the Gulf of Mexico. It is now drilling in the Black Bay area about 20 miles southeast of New Orleans.

Because of the long, slow trip out by boat, everything on the "Laguna Madre" was chosen for its ability to stand up in service. That's why they selected American Tiger Brand Preformed Wire Lines. From previous experience, the contractor knew that Tiger Brand stood at the top of the list for performance.

The Rotary Drilling Line is 2500 feet of 1¼" diameter 6 x 19 Monitor Improved Plow Steel with wire core. This has been in operation since January 14, 1950 and has given excellent service. They keep a careful check for signs of wear and cut off a section of line occasionally to distribute the wear. At the proper time, the line is reversed and the process repeated. Many thousand ton-miles of service are added by this kind of care.

Our booklet, "Valuable Facts about the Use and Care of Wire Rope," contains many other suggestions that will add appreciably to line life. Send the coupon for a copy.

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THE "LAGUNA MADRE" Drilling Barge, owned by Brewster-Bartle, Drilling Contractors. One of the finest rigs on the Gulf Coast—equipped with American Tiger Brand Wire Rope.

SEND FOR THESE BOOKLETS!

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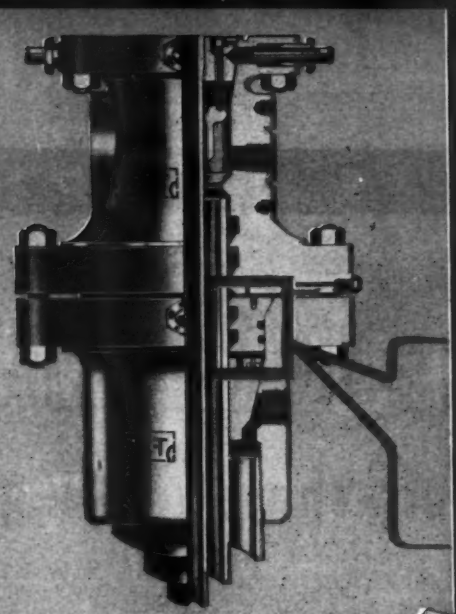
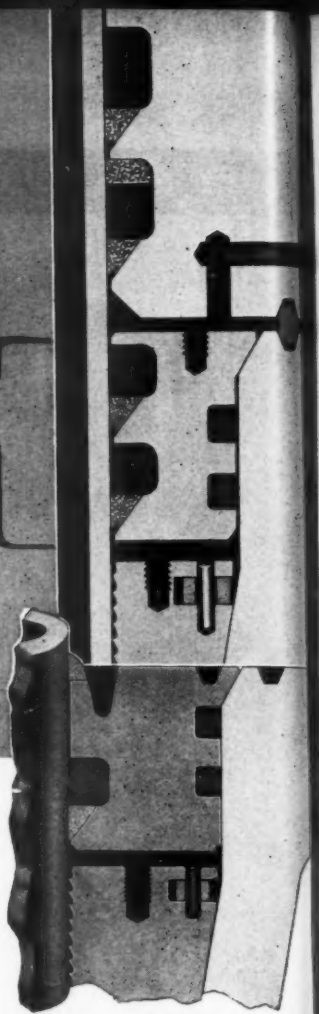
SLIPS AND SEAL ARE SEPARATE



The seal is available in oversized "O" Ring Seals (above right) or a combination welded and oversized "O" Ring (below, right).



IN THIS NEW O-C-T 20,000 LB. TEST

AUTOMATIC FLOATING SEAL

Outstanding among the many features of this new O-C-T "C-18-H" hanger is the design which allows slips and seal to work independently. When a 20,000 lb. test load is applied, for example, the load is applied to the automatic sealing element and not to the slips. This feature removes any possibility of collapsing or crushing pipe with test loads. The test load is applied to the heavy bevel on the body of the head. In addition, Allen screws have been eliminated from the design and well pressure is utilized to equalize the seal all around the pipe. Extra heavy seals are backed up by extrusion rings which conform to the plus or minus API tolerance of the casing. Corrosive gas and fluids are sealed off from the API Metal Ring Gasket between flanges.

Check and compare this new O-C-T "C-18-H" Casing Head with any other head. It provides maximum safety, simplicity and flexibility. Write today for engineering details and prices. O-C-T Products are always dependable and available through more than 700 conveniently located supply stores.

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These Aldrich 5" Stroke Direct Flow Pumps are:

NEW IN DESIGN
•
LOWER IN PRICE
•
ECONOMICAL TO MAINTAIN

Aldrich 5" Stroke Direct Flow Septuplex Pump

● A partially dismantled 5" Stroke Direct Flow Triplex Pump. The fluid-end block is bolted to the top of the frame. The suction and discharge manifolds, bolted to the working barrel, serve as clamps to hold the valves in place. To remove valves, it is only necessary to remove the nuts from the holding studs. Manifolds can then be slid on the studs, affording sufficient room to remove and replace valves which are assembled in complete units for ease of handling.

Making quality construction available at a *new low in price,* Aldrich 5" Stroke Direct Flow Pumps are designed for serviceability and economy of maintenance. Built in 3, 5, 7 and 9 cylinder units, the series ranges from 75 to 275 hp and handles almost all liquids encountered in oil field and petroleum service.

NEW IN DESIGN: One outstanding advantage of these pumps is the *sectionalized* fluid-end. Combining several separate units, the fluid-end consists of: a working barrel, valve assemblies, stuffing boxes, and suction and discharge manifolds. Designed to afford close clearance volumes and direct flow, these pumps are ideal for handling light as well as heavy liquids. Removable stuffing boxes and two basic sizes of fluid-ends permit change of plungers, from 1¾" to 3½" diameter, to meet desired pressure and capacity requirements.

ECONOMICAL TO MAINTAIN: As a result of the sectionalized fluid-end, one man can easily remove and replace valve assemblies. And individual fluid-end parts can now be replaced at a *fraction of the cost* of a composite type fluid-end. Other savings include: interchangeability of wearing parts, less costly pump housing, lower foundation expense, low skidding cost, ease of portability, and light weight.

Write—without obligation—for complete information. Request Data Sheet 64-B.

Representatives: Birmingham • Bolivar, N. Y. Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Duluth • Houston Jacksonville • Los Angeles • New York • Omaha Philadelphia • Pittsburgh • Portland, Ore. Richmond, Va. • St. Louis • San Francisco Seattle • Spokane, Wash. • Syracuse • Tulsa

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All Aldrich Pumps Have **STAYING POWER**

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PROTECT or PAY

You have no other choice!

There are just two reasons why corrosion costs industry over $6,000,000,000 annually:

1. To the layman, corrosion usually means only visible rust—thus many surfaces are left unprotected until irreparable damage is done.
2. Too often conventional coatings are relied on to protect under conditions for which they are neither designed nor suited.

Don't risk needless loss from either cause. Protect all critical surfaces with Amercoat – the products designed to give *extra protection* against surface failure. Highly resistant to a wide variety of chemicals, brines, fumes, weathering and abrasion, they are available in a number of formulas, each built to meet specific conditions.

No business escapes the effects of corrosion. You must protect or pay, and it will pay you to protect *now* with Amercoat.

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Piping • Machinery
Walls and Ceilings
Fixtures • Tanks
Floors • Conveyors
Laboratory Equipment
. . . and all other areas exposed to agents of corrosion or contamination

AMERCOAT CORPORATION

A Division of
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FOLLOW THE LINE OF *most* RESISTANCE

JUNKED BEFORE ITS TIME–

This costly storage tank, due to failure of a conventional coating, served but half its life expectancy. The result—thousands of dollars for replacement, interrupted operations and needless waste.

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YOU DON'T HAVE TO PAMPER

THE "King-clip" VALVE!

Fig. 1640

Iron Body Bronze Mounted "KING-CLIP" Gate Valve 150 lb. S.P.—200 lb. W.O.G. For steam, water, gas, air, oil and gasoline service.

THIS STURDY IRON BODY GATE VALVE is built to stand the gaff of hard usage. It is a composite of the strong construction of the original "Clip" valve pioneered by Lunkenheimer many years ago and improved design features to meet modern-day conditions. It provides maximum resistance to distortion, piping stresses and wrenching strains.

Aside from its basic rugged proportions, the "KING-CLIP" embodies these distinctive features: • non-corrosive stem-thread bearing cast in bonnet • large drain channels that really drain the bonnet • sharply tapered bronze disc that seats tight • bronze rolled-in seat rings • coarse stuffing box threads that resist corrosion and stripping • hexagon head gland • Lunkenheimer-developed stem material that eliminates stem-thread failure due to wear • easy disassembly for servicing.

Ask for Circular No. 561 which illustrates the numerous patterns in which the "KING-CLIP" is available—iron body trim with bronze and various alloys, and all-iron . . . for a wide variety of services. You'll find one or more types which you can use to profitable advantage.

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save you money...and "headaches"!

Distributors' stocks and service are a money-saving and time-conserving convenience. The more you use these handy facilities, the less you need spend for stock-room inventory and "sleuthing" for sources of supply. Call your Lunkenheimer distributor and profit from his unfailing service—not only on valves, but on the numerous other commodities necessary to keep industry in pace with the needs of these fast-moving times.

ESTABLISHED 1862

THE LUNKENHEIMER CO.

"QUALITY"

CINCINNATI 14, OHIO, U.S.A.

NEW YORK 13 • CHICAGO 6 • BOSTON 10 • PHILADELPHIA 34

EXPORT DEPT. CINCINNATI 14, OHIO, U.S.A.

The "King-clip" is king of all clip type valves!

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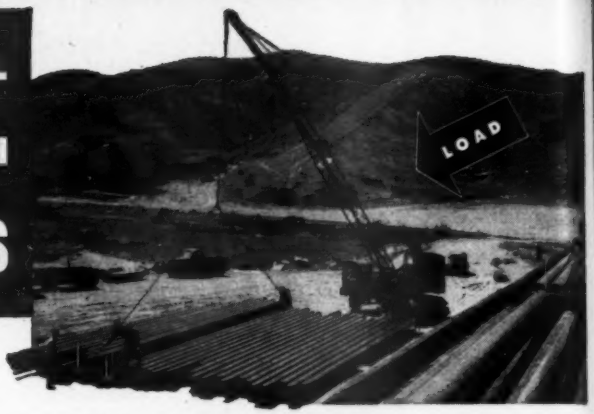
READY TO *Roll* ALL ALONG THE LINE WITH LORAIN MOTO-CRANES



Humiston-Rosendahl, Inc., Los Angeles, Calif., own two Lorains. Unloading and racking pipe, as shown, is but one of many jobs for their Lorain "TL" Moto-Crane. It is also used on pipeline construction and steel tank erection at a refinery.

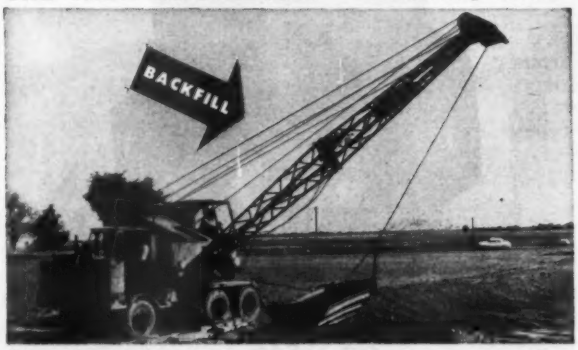
When the job says "Go" — Lorain Moto-Cranes are there in a jiffy. They roll on rubber — down the highway at up to 30 MPH, on rugged right-of-way, or unsurfaced back roads. That's because Moto-Cranes have the speed, the power, the soft-ground flotation and the tractive effort to meet the constantly changing demands of pipeline operations.

And when they get on the job, just look what they can do! These four illustrations are typical applications. But in addition, Moto-Cranes can clam out cave-ins, dig river crossings, gate valve holes, place gate valves and vents — pull, lay, bend pipe, handle materials of all kinds — there's work for Lorains all along the line!

Lorain Moto-Cranes are available in crane capacities from 10 to 45 tons — with 5 interchangeable booms — 2 or 3 axle carriers with 4 or 6 wheel drive. Your Thew-Lorain Distributor offers the "World's Largest Selection on Rubber-Tires". And when you investigate, remember — "It Isn't a Moto-Crane Unless It's Built by Thew-Lorain"!

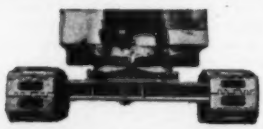
THE THEW SHOVEL CO. • LORAIN, OHIO

Shell Pipeline Co., Houston, Texas, used a Lorain "TL" Moto-Hoe on this ditching job near Bland, Missouri. Note the goose-neck boom for deep ditch clearance.



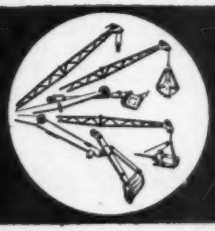
It's another job for the Oklahoma Contracting Co. — and another Lorain on the 20 inch pipeline for the Michigan-Wisconsin Pipeline Co. near Hobart, Indiana. The Moto-Crane with backfiller board reaches across the ditch to backfill quickly and neatly. There's no chance of damage to adjacent property with this method.

Oklahoma Contracting Co. of Dallas, had plenty of use for this Lorain "TL" Moto-Crane on their 103 mile pipeline from McConnel, Tenn. to Slaughter, Ky. The Moto-Crane with clamshell bucket is shown digging rock at a road crossing.



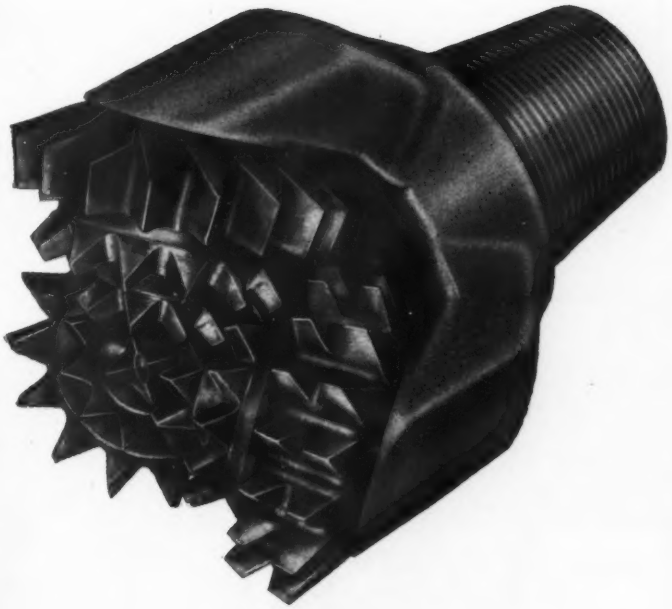
SPECIAL! — LORAIN "PIPELINERS"
Lorain "Pipeliners" for *ditching* jobs. Two sizes — Junior and Senior — extra-wide crawlers to straddle ditches and many other special "pipeliner" features.

THEW **LORAIN**® *on CRAWLER or RUBBER*



SHOVELS
CRANES
DRAGLINES
CLAMSHELLS
HOES

for high speed drilling in medium hard formations



CP Type EM three cone rock bits—designed to operate at high speed with heavy weights—are unexcelled for drilling in medium hard rock formations, such as lime rock, dolomite, anhydrite and hard shale.

Cones and bearing journals are of high alloy forged steels, accurately machined and carefully heat-treated, with special hard-facing of the teeth on the cones—assuring the long service demanded in modern drilling operations.

Type EM bits are furnished in various types and sizes to meet specific drilling requirements in different oil fields.

Prompt service is assured in the Mid-Continent, Rocky Mountain and Canadian fields.

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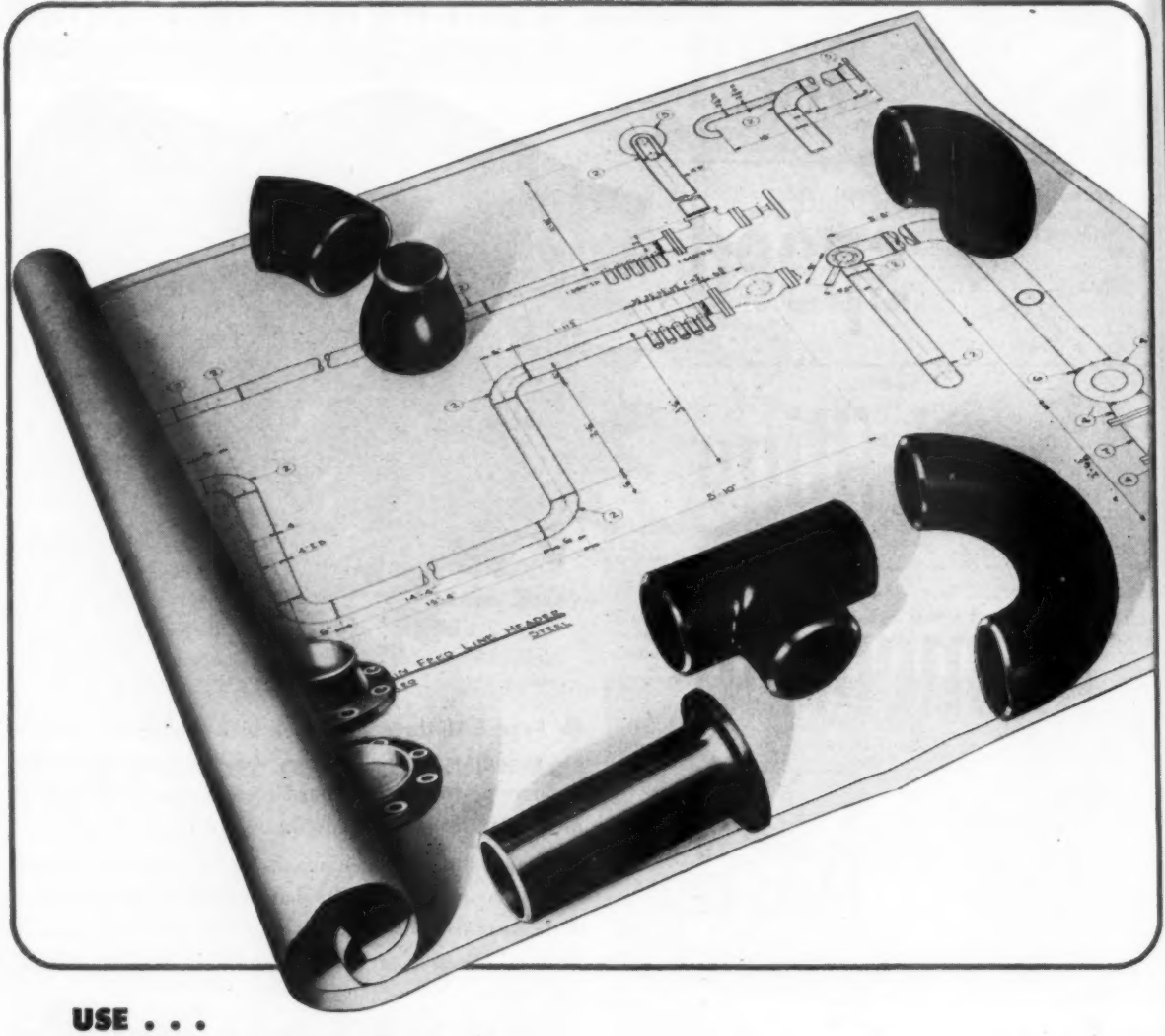

USE . . .

GLOBE PRECISION PROCESS SEAMLESS WELDING FITTINGS

When you specify and use Globe Welding Fittings you have the product of an organization with unusually broad metallurgical experience. Globe's precision-process method of production reaches back to the manufacture of the Globe seamless tubes themselves which are the "raw material" of Globe welding fitting fabrication.

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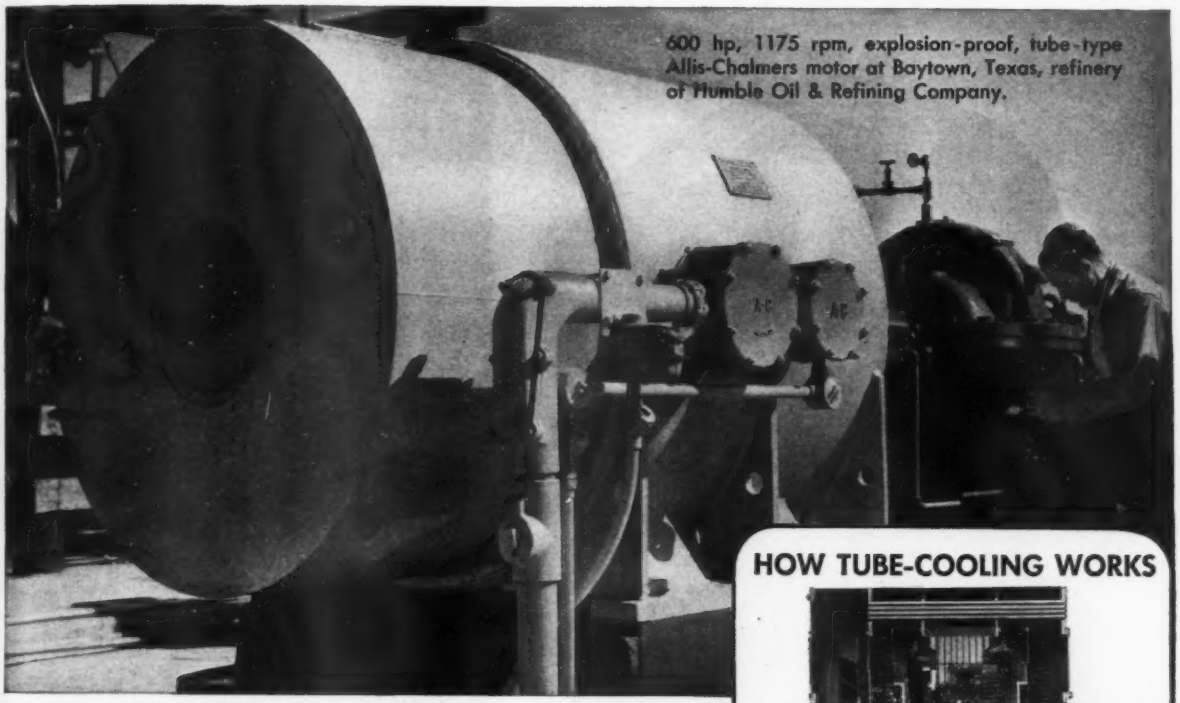
Send for the Globe Welding Fittings Catalog—and look to Globe as a preferred source of supply.

STRAIGHT FLOW OF AIR MAKES TUBE-TYPE TEFC* MOTORS

Self-Cleaning



600 hp, 1175 rpm, explosion-proof, tube-type Allis-Chalmers motor at Baytown, Texas, refinery of Humble Oil & Refining Company.

*TEFC MEANS—*Totally Enclosed, Fan Cooled*

YOU CAN GET THE SAME PROTECTION against explosive vapors in refinery and allied operations that Humble Oil & Refining company gets with its Allis-Chalmers tube-type motors.

This *new* type of motor is self-cleaning. Cooling air flows through straight, smooth tubes. There are no recesses to collect moisture and dirt as in conventional designs. Heat exchanger type of cooling reduces weight of the motor. The tube-type design has been adapted to the most severe corrosive conditions found in refineries or chemical plants.

It is now available with Underwriters Laboratories' label from 125 to 800 hp, 3570 rpm, with corresponding ratings at lower speeds.

For more information, get Bulletins 51R7149 and 05B7150.

A-3028

ALLIS-CHALMERS, 1059A SO. 70 ST.
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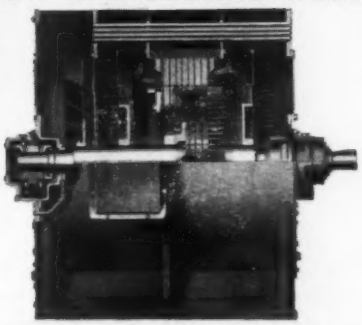
HOW TUBE-COOLING WORKS



1. Efficient air flow combined with large heat transfer area for quick heat removal. 2. Free from dirt and moisture collecting obstructions. 3. *Internal* fans circulate inside air for rapid heat dispersal. 4. *External* fan blows cooling air through tubes. 5. All electrical parts completely enclosed for maximum protection from dirt and corrosive atmospheres.

ALLIS-CHALMERS

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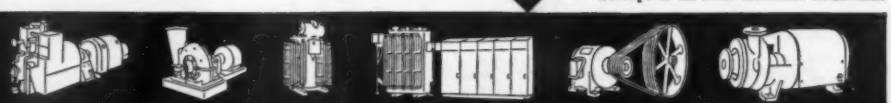
Power, Electrical, Processing Equipment for Petroleum Industry



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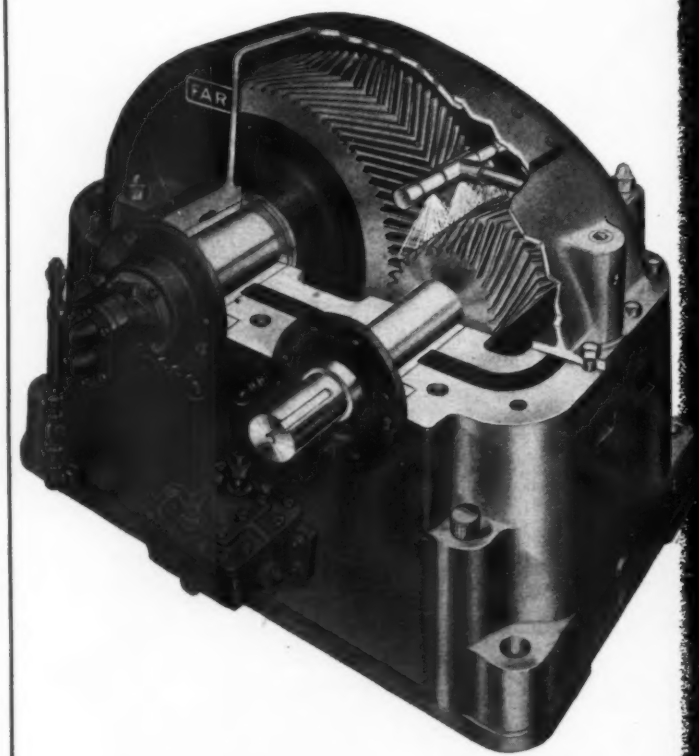
5 REASONS WHY
FARREL® SPEED INCREASERS "LAST FOREVER"



While we cannot *guarantee* that Farrel type SI units will *last forever,* it is beginning to look as though they will.

Since 1932, when we first developed a standard series of speed increasers for pipe-line pumping service, hundreds of these units have been installed throughout the oil industry. *Every one of these units is still in operation,* performing as well as on the day it was put into service.

For full information about these *time-proved* speed increasers, write for your copy of Bulletin No. 448. No cost, no obligation.

FARREL-BIRMINGHAM COMPANY, INC., Ansonia, Connecticut

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Farrel-Birmingham®

FB-577

THE GEAR WITH A BACKBONE

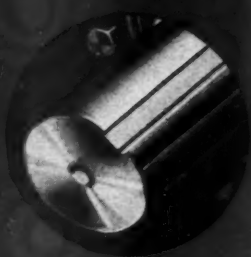
Precision generation by the famous Farrel-Sykes process, evenly distributed load, overlap or interlocking of the teeth, gradual engagement and inclined line of pressure keep power-transmission efficiency "fresh" through long years of service.

A "FOUNTAIN OF YOUTH"

The completely self-contained circulating oil system virtually gives power an "overhaul" by providing a protective spray of oil at the mesh line of the gears and, at the same time, pressure-lubricating the bearings.

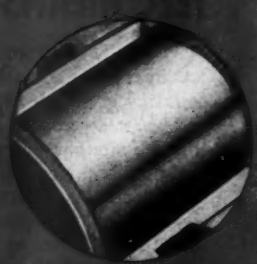
PRECISION-GROUND SHAFTS

Extra large for the power to be transmitted. Give added stiffness against bending and torsional deflections under peak loading variations.



OVERSIZE SLEEVE BEARINGS

With consequent low unit pressures. Precision finished to extremely close tolerances.



EXCEPTIONALLY RIGID HOUSING

Rugged construction assures alignment, insuring maintenance of operating smoothness of the precision gear-reduced gearing.

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Take an Idea

ON A NEW USE FOR A JET

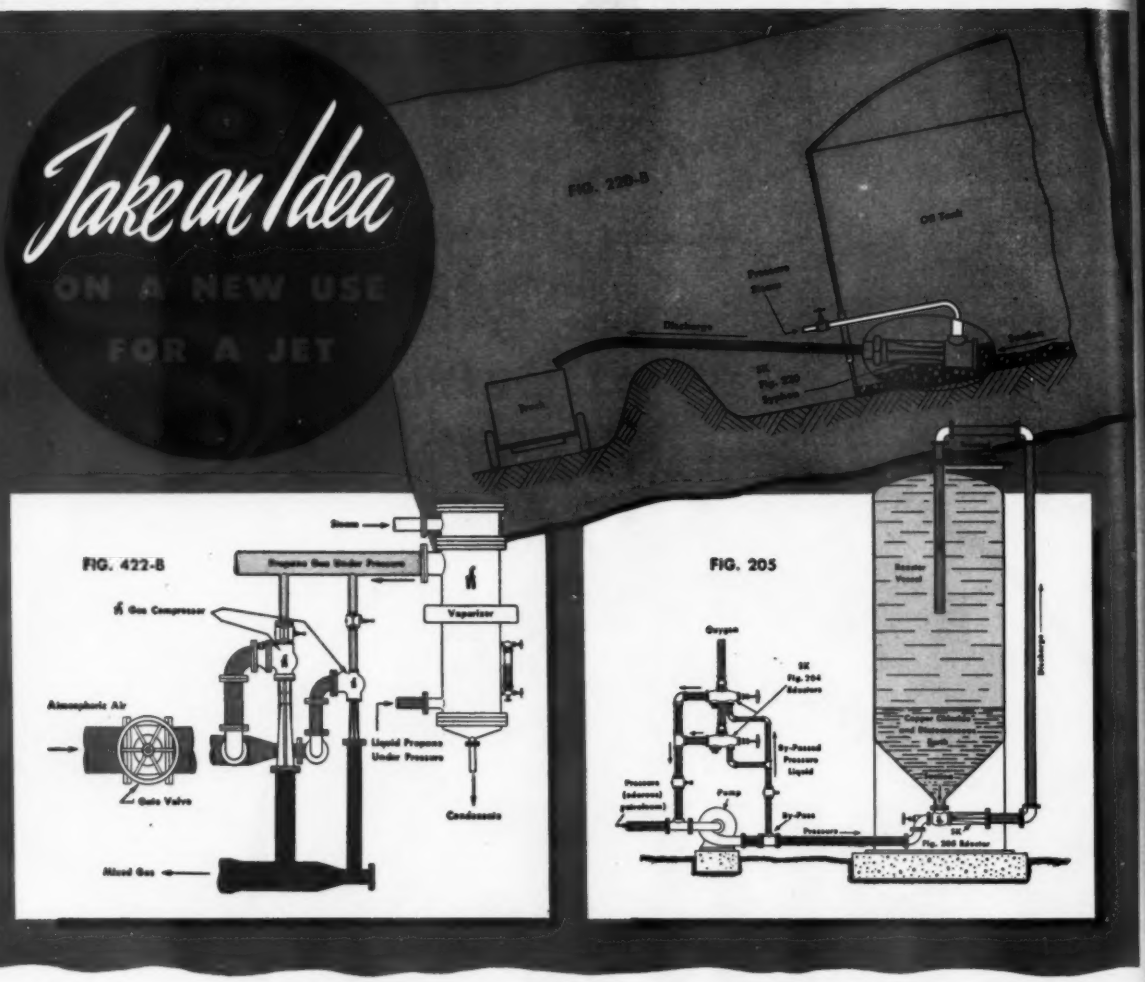

FIG. 220-B. In this application, an SK Fig. 220 Steam Jet Syphon is used to clean sludge from the bottom of an oil tank.

FIG. 422-B. Two SK Gas Jet Compressors are used to mix propane gas under pressure with atmospheric air. Variations in capacity and the proportion of the mixture can be closely controlled.

FIG. 205. In this application two SK Fig. 204 Water Jet Eductors and an SK Fig. 205 Eductor are being used in a process designed to convert malodorous compounds in petroleum products into compounds with a marketable odor.

TURN it over to SK engineers and watch it develop—in most cases, into an economic method of doing a job better and faster with SK *"Job Engineered"* Jet Apparatus. That's how the applications you see illustrated above came about.

Over the years, many petroleum engineers have come to SK for the solution to some producing, transporting, gas processing, or refining problem. Working with these engineers, and solving the many problems encountered, has given SK employees a wealth of engineering knowledge involving the use of all types of Jet Apparatus from Steam Jet Injectors, through Water Jet Eductors, Jet Primers and Exhausters to Fume Scrubbers.

We CAN help YOU with your problem by recommending a standard product, designing a new model or, if an engineering analysis indicates that Jet Apparatus cannot meet your requirements, by frankly informing you of the facts and recommending some other type of equipment.

To give you some idea of the equipment available, we offer our Folder of Jet Apparatus. Send for it.

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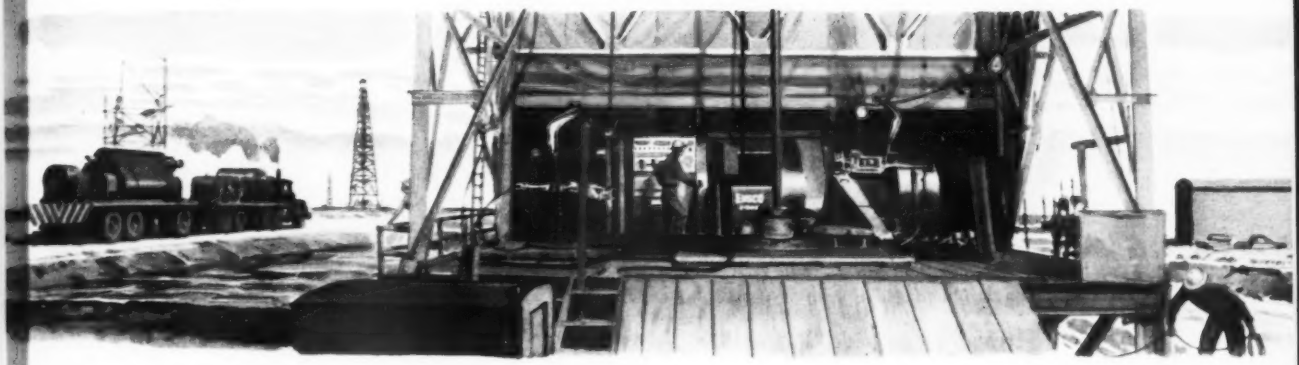
Packaged design OF EMSCO "J" SERIES DRILLING RIGS...



★ **ELIMINATES LONG CHAIN AND V-BELT DRIVES**

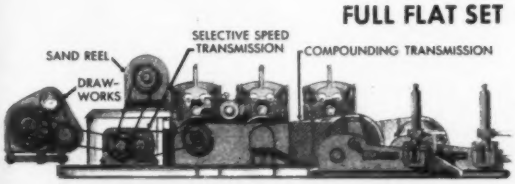
★ **PROVIDES MAXIMUM VERSATILITY TO VARYING HEIGHT SUBSTRUCTURES**

★ **INSURES GREATER PORTABILITY, LESS SET-UP AND TEAR-DOWN TIME**

The exclusive "packaged design" of Emsco J-Rigs provides unlimited installation versatility and portability. Drawworks, selective speed transmission and compounding transmission can be placed in the best possible position to meet the particular requirements of each location. Rigs may be full flat-set, or set in a wide variety of stair-step arrangements to accommodate any height substructure for barge, piling or land installation. The design permits heavy engines and transmission to remain at ground level. The need for costly, cumbersome sub-bases to raise engines and compounding transmission to derrick floor level is eliminated. Hauling weight is materially reduced. Chain and v-belt slush pump drives are kept to the shortest possible length.

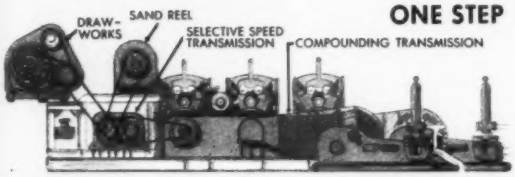
TYPICAL SETTINGS

FULL FLAT SET



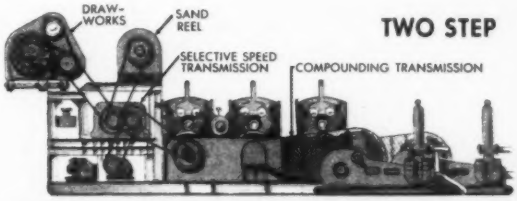
Drawworks, selective speed transmission, compounding transmission and slush pump set at derrick floor level. Optional sand reel set on light sub-base over selective speed transmission. This type of setting is generally used for offshore barge and piling locations, as well as land installations.

ONE STEP



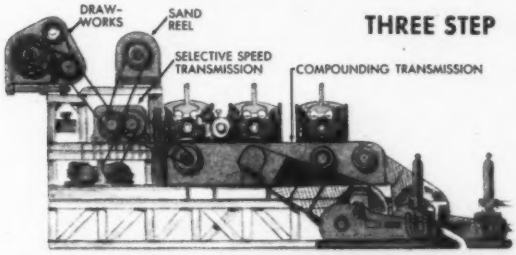
Drawworks set at derrick floor level with selective speed transmission, compounding transmission and slush pumps at ground level. Optional sand reel located directly above selective speed transmission at derrick floor level. This type setting generally used with seven foot high substructures.

TWO STEP



Most common arrangement. Compounding transmission and slush pumps set at ground level with selective speed transmission stair-stepped intermediate between compounding transmission and drawworks. Optional sand reel set directly above selective speed transmission.

THREE STEP



A special setting generally employed for deep drilling operations requiring heavy blow-out preventer equipment and extra-tall substructures (14 to 20 feet high). Compounding transmission set on three to seven foot sub-base. Slush pumps located at ground level for maximum efficiency. Note extremely short chain and V-belt drives.

The packaged design of Emsco J-Rigs increases the efficiency of every phase of drilling. It makes Emsco J-Rigs the most versatile, efficient and portable power rigs available today.

ADV #53F-50

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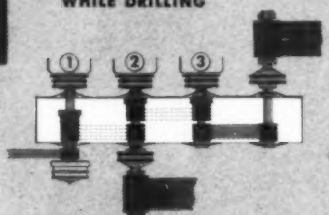
EMSCO "J" SERIES COMPOUNDING TRANSMISSIONS

UNEXCELLED FOR POWERING ANY MAKE, SIZE OR TYPE OF DRAWWORKS... *New or Old!*

Emsco Compounding Transmissions may be used with equal efficiency for driving any type or make of power drawworks, or for converting a steam drawworks to a power rig. By using an Emsco reverse clutch and compounding transmission, you can now economically convert your steam drawworks to an efficient power rig with a minimum of expense and down-time. Your nearest Emsco representative will show you how you can improve the performance of your drawworks with an Emsco J-Series Compounding Transmission. Your inquiry is invited.

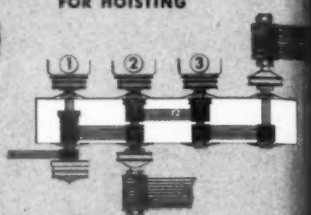
TYPICAL DRIVE ARRANGEMENTS

1 FOR MIXING MUD WHILE DRILLING



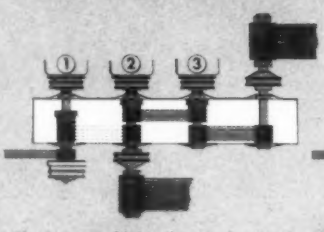
No. 1 engine on drawworks. No. 2 engine on side pump circulating mud. No. 3 engine driving back pump for mud mixing. Pumps may be driven at different speed simultaneously. All shaft clutches disengaged.

3 ENGINES COMPOUNDED FOR HOISTING



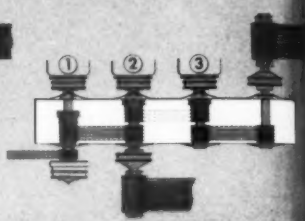
All gear tooth clutches engaged, compounding power of all three engines for powering drawworks. Slush pumps Fawick clutches disengaged.

2 ENGINES COMPOUNDED FOR DRIVING ONE OR BOTH PUMPS

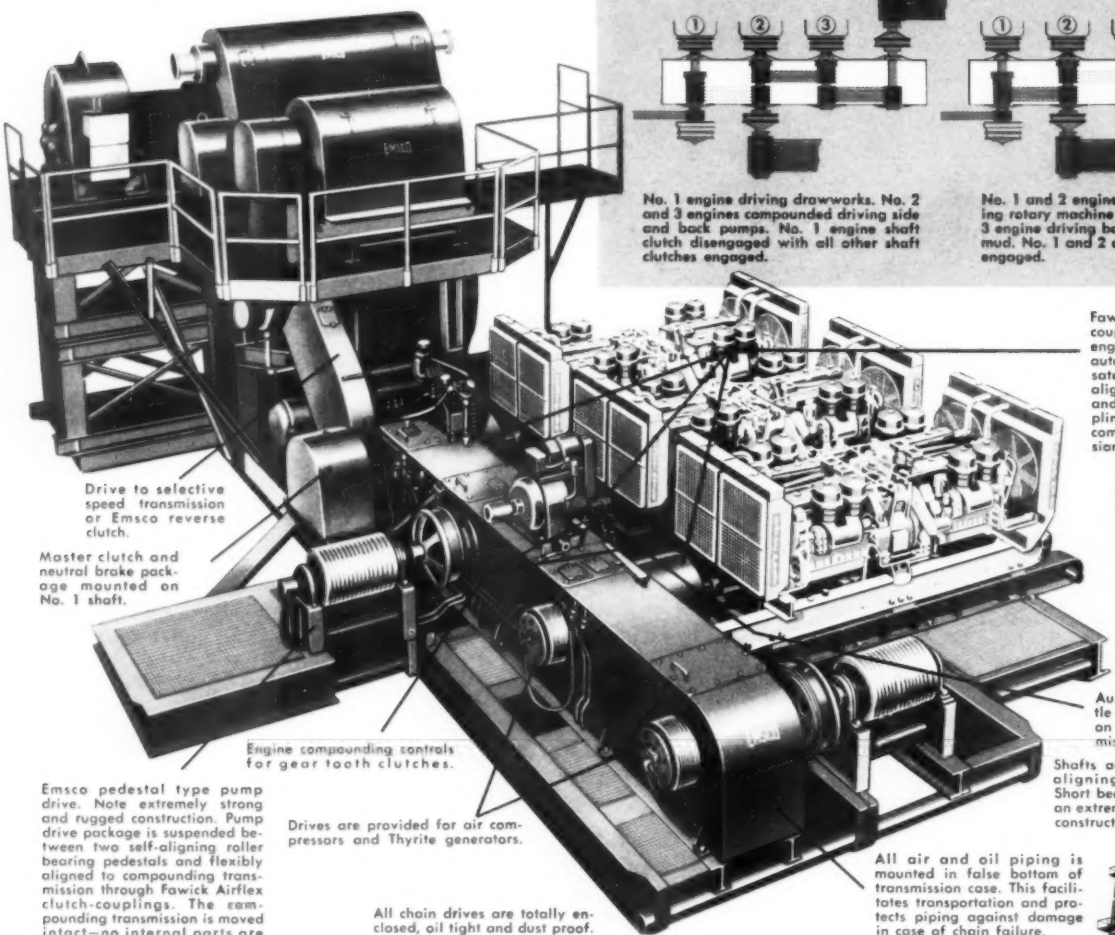


No. 1 engine driving drawworks. No. 2 and 3 engines compounded driving side and back pumps. No. 1 engine shaft clutch disengaged with all other shaft clutches engaged.

4 ENGINES COMPOUNDED FOR DRILLING WHILE MIXING MUD



No. 1 and 2 engines compounded driving rotary machine and side pump. No. 3 engine driving back pump for mixing mud. No. 1 and 2 engine shaft clutches engaged.



Drive to selective speed transmission or Emsco reverse clutch.

Master clutch and neutral brake package mounted on No. 1 shaft.

Engine compounding controls for gear tooth clutches.

Emsco pedestal type pump drive. Note extremely strong and rugged construction. Pump drive package is suspended between two self-aligning roller bearing pedestals and flexibly aligned to compounding transmission through Fawick Airflex clutch-couplings. The compounding transmission is moved intact—no internal parts are exposed to the elements.

Drives are provided for air compressors and Thyrite generators.

All chain drives are totally enclosed, oil tight and dust proof.

Fawick Airflex clutch-couplings are used for engine clutches. They automatically compensate for any minor misalignment of engines and permit close coupling of engines and compounding transmission.

All shaft bearings and chain drives are pressure oil lubricated by circulating oil bath lubrication system.

Two large slush pumps may be used. This eliminates need for costly independent slush pump unit.

Auxiliary engine throttle controls are mounted on compounding transmission.

Shafts are mounted on self-aligning roller bearings. Short bearing centers provide an extremely strong and rigid construction.

All air and oil piping is mounted in false bottom of transmission case. This facilitates transportation and protects piping against damage in case of chain failure.

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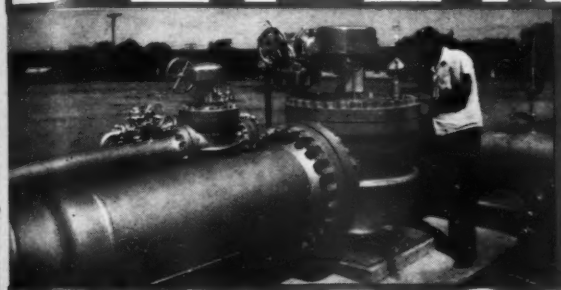
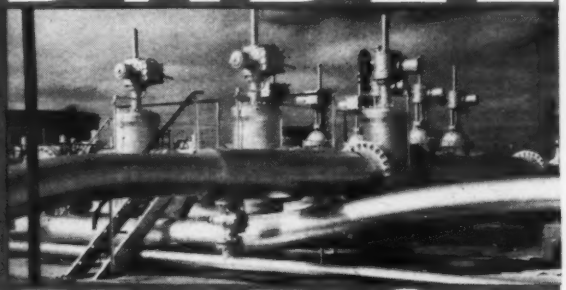
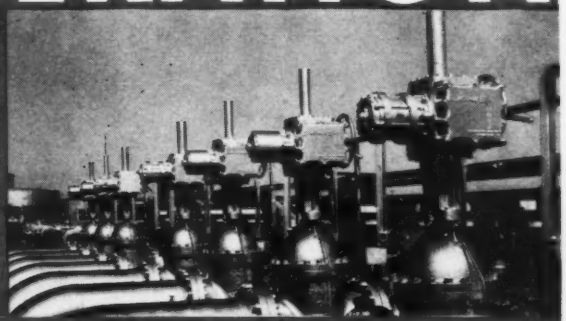
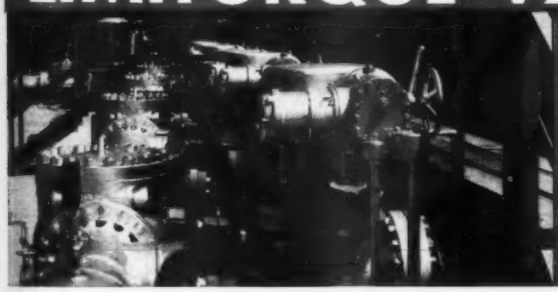


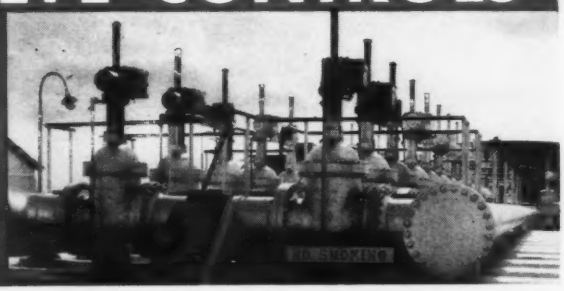


VALVE OPERATION



LIMITORQUE VALVE CONTROLS





Hundreds upon hundreds of LimiTorque Valve Operators are used on Pipe Lines and in Refineries throughout the world, because they operate (at the mere "push of a button") . . . under the most severe conditions of Heat or Cold, Rain, Snow, Dust, Dirt or Fumes . . . night and day . . . year-in and year-out—LimiTorque saves time, labor and money by *eliminating* manual operation of valves at distant locations. It opens and closes valves at the exact speed required, and is *absolutely* dependable and safe. Also, as the name implies, LimiTorque limits the torque applied to valve operating parts, and thus prevents damage to stems, discs and seats, etc.

LimiTorque utilizes any available power source for operation: electricity, oil, gas, water or air. You take no chances with LimiTorque, because it has been tested and time tried under all conditions.

Philadelphia Gear Works, INC.

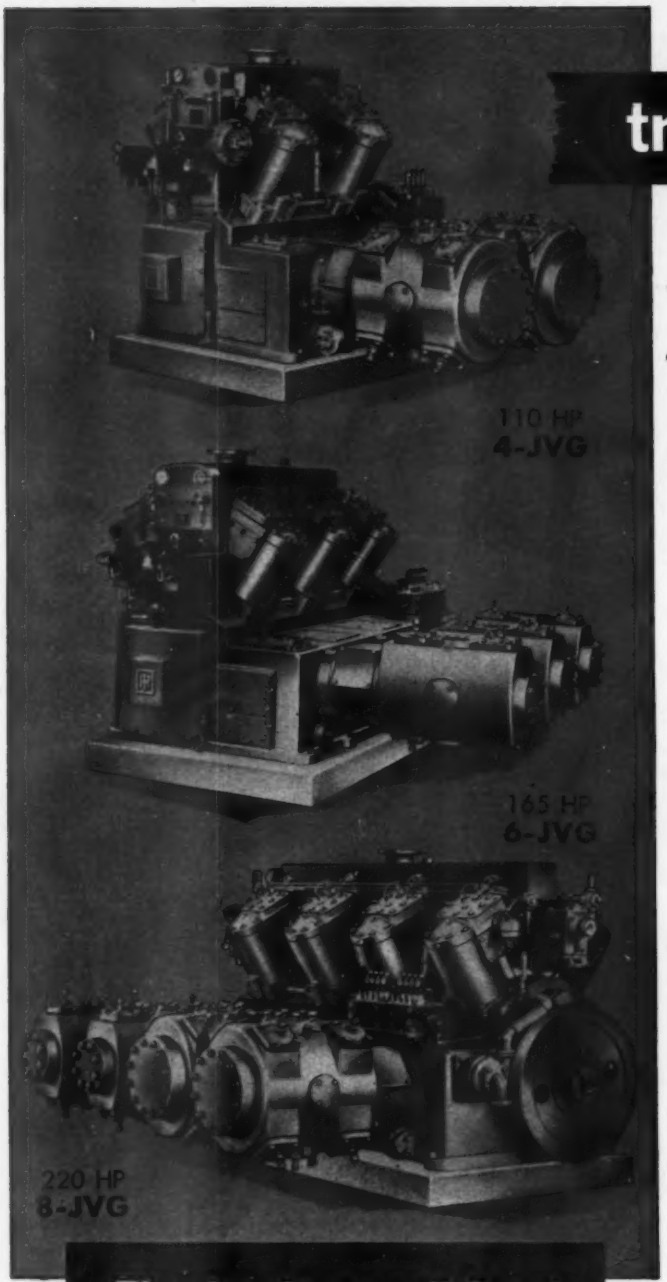
ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK • PITTSBURGH • CHICAGO • HOUSTON

IN CANADA: WILLIAM AND J. G. GREEY LIMITED, TORONTO

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

XUM



try these for size

...and economy!
...and performance!

The light-weight, gas-engine-driven JVG is now available in three sizes ... 110, 165, and 220 horsepower ... for refinery or oil field service. Excellent running balance of these Ingersoll-Rand 4-cycle V-angle compressors, needing only small foundations, makes them ideal for skid mounting and jobs where frequent relocation is necessary.

The JVG is designed for maximum flexibility of loading, to meet any pressure conditions ... any gas ... any service. Maintenance men and operators praise its heavy-duty construction, economy of fuel and lube oil, and simplicity and compactness. They also like the perfect combustion and smooth, quiet 4-cycle operation under all load and speed conditions.

These units will meet your most exacting specifications for high efficiency, conservative rating, long life and low maintenance ... whether the job be for semi-portable use or permanent installation. Consult your nearest I-R representative for complete details.

Horsepower	Width	Length	Height
110	6'-2"	8'-5"	6'-3"
165	8'-3"	8'-5"	6'-3"
220	10'-4"	8'-5"	6'-3"

They're Ingersoll-Rand
JVG
GAS-ENGINE-DRIVEN
COMPRESSORS

4-CYCLE V

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

522-6

COMPRESSORS • AIR TOOLS • CONDENSERS
• ROCK DRILLS • TURBO BLOWERS •
CENTRIFUGAL PUMPS • OIL & GAS ENGINES

Types XVG, SVG and KVG gas-engine-driven compressors are available for installations requiring larger horsepower ratings.

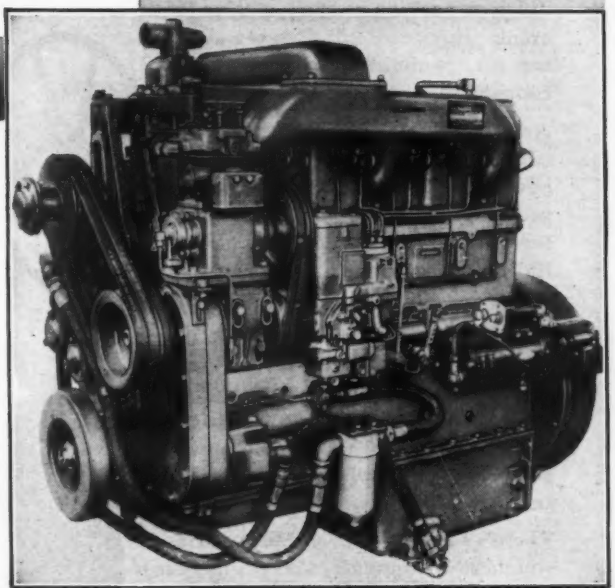
XUM

FLEXIBLE HOSE LINES

WITH DETACHABLE, REUSABLE FITTINGS

Save time, save money and reduce inventory by putting the "Aeroquip Idea" to work for you. With Aeroquip you make your own flexible hose assemblies by cutting bulk hose to desired lengths and attaching Aeroquip Reusable Fittings. Assembly can be accomplished quickly and easily right on the job. No special tools are required. No training is needed. Aeroquip high quality Flexible Hose Lines improve performance and reduce maintenance. They eliminate leaks due to vibration and operate dependably at extremely high or low temperatures. They are widely used for hydraulic fluid, water, air, lubricating oils, gas and Diesel fuels and many other fluids.

Always first
ON DIESEL ENGINES



Because this Diesel Engine is plumbed with Aeroquip Flexible Hose Lines, replacement of any fluid-carrying line can be accomplished in a fraction of the time required for forming and fitting rigid tubing. Aeroquip Hose Lines are fire resistant and eliminate failure due to vibration.

Always first
REG. TRADE MARK

B.D. Check into this money saving idea—Jobber

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JACKSON, MICHIGAN

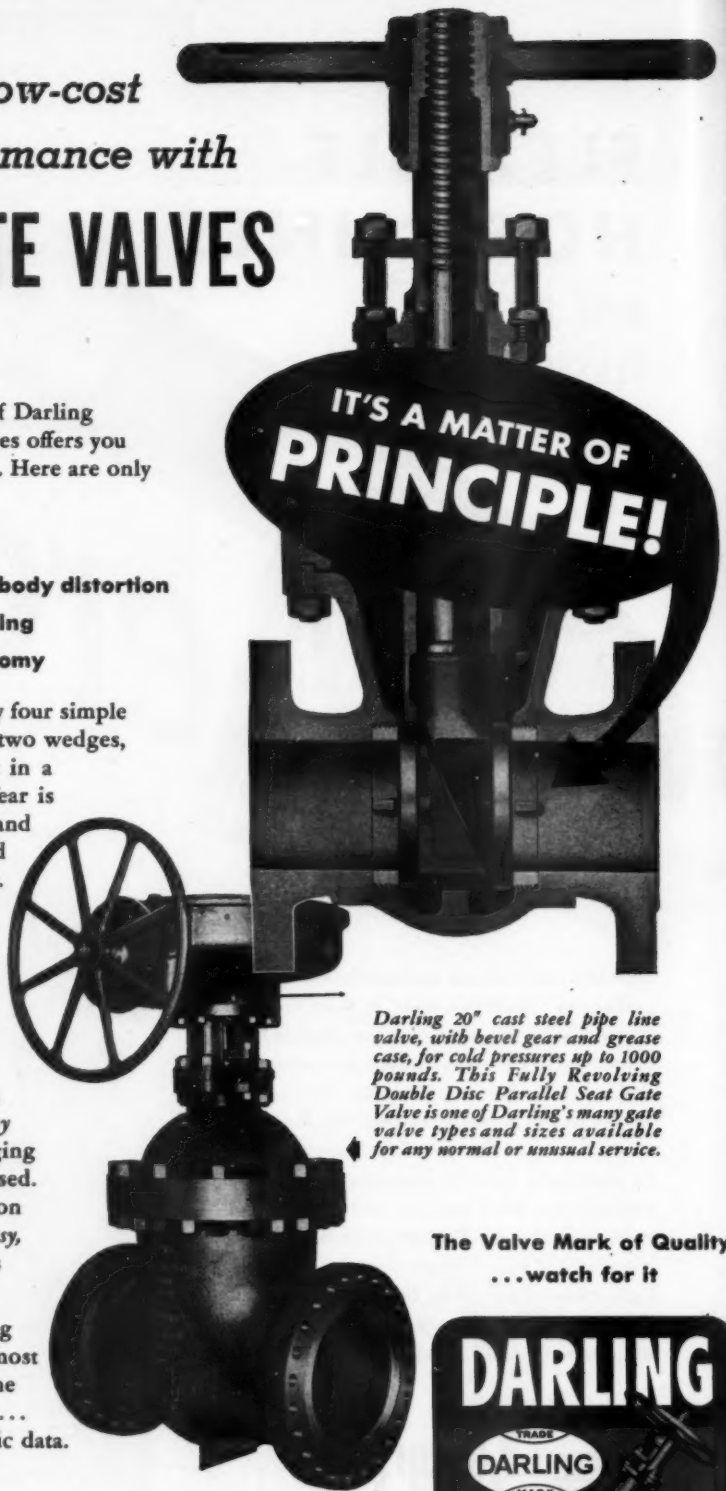
SALES OFFICES AND WAREHOUSES: 1053 NO. HOLLYWOOD WAY, BURBANK, CALIF. 1215 SO. EAST GRAND AVE., PORTLAND 14, ORE. 2912 N. E. 28TH ST., FORT WORTH 11, TEXAS 72-74 STAFFORD STREET, TORONTO, CANADA 4301 N. W. 36TH ST., MIAMI SPRINGS, FLORIDA

SALES OFFICES: 303 WAREHAM BLDG., HAGERSTOWN, MD. 1419 2ND AVE., SO., MINNEAPOLIS 4, MINN.

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U. S. A. AND ABROAD

You'll cinch low-cost trouble-free performance with

DARLING PIPE LINE GATE VALVES



THE unique operating principle of Darling Revolving Double Disc Gate Valves offers you a number of cost-reducing advantages. Here are only four of the major ones . . . .

1. **Positive easy closing**
2. **Automatic adjustment for valve body distortion**
3. **Elimination of gate-to-seat galling**
4. **Unsurpassed maintenance economy**

HERE'S WHY. As shown, there are only four simple working parts in the gate assembly—two wedges, two discs free to *revolve!* Discs seat in a different position at every closing. Wear is evenly distributed, prolonging disc and seat life, minimizing maintenance and contributing to positive, tight closing.

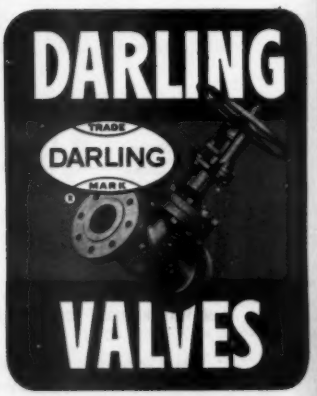
Next, note how face of upper wedge is radiused. Faces are also transverse beveled. This equalizes wedging pressure and *automatically* adjusts for valve body distortion, avoiding leaks, down-time and costly repair.

Finally, see how wedging pressure is exerted *only* when discs are *all the way down,* directly opposite seats. Wedging pressure is released *before* discs are raised. Obviously this eliminates severe friction and galling, makes valve operation *easy,* and prolongs trouble-free life of discs and seats.

There's a Darling Valve ready to bring you these and other advantages in almost any service you can name! Send for the 300-page Darling Catalog No. 17M . . . or identify your needs and get specific data.

Darling 20" cast steel pipe line valve, with bevel gear and grease case, for cold pressures up to 1000 pounds. This Fully Revolving Double Disc Parallel Seat Gate Valve is one of Darling's many gate valve types and sizes available for any normal or unusual service.

The Valve Mark of Quality
. . . watch for it



Darling Valve & Manufacturing Co.

Williamsport 1, Pa.

When corrosion strikes your equipment, two things happen.

Production drops—and costs go up.

Ordinarily, that's bad. But the picture has a bright side, too.

Here's your chance to strike back at corrosion, your chance to put in equipment that may deliver two or three or more times the service you've been getting!

Such equipment is made of "K"® Monel.

This non-magnetic nickel alloy is widely used for many types of sub-surface equipment that operate with gas and crudes containing hydrogen sulfide, brine and entrained solids.

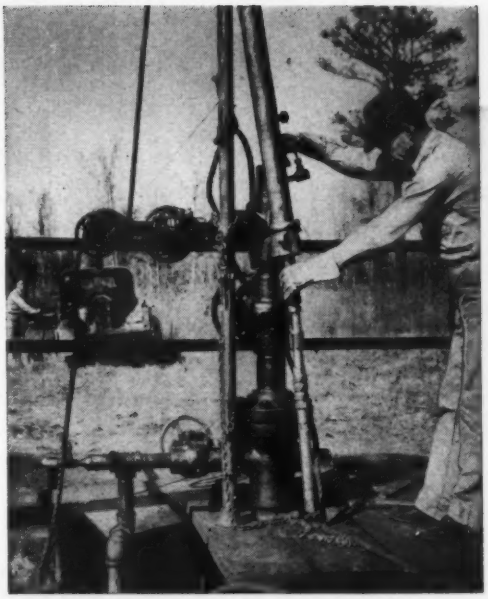
How to CUT PRODUCTION PROBLEMS and EQUIPMENT COSTS

Like all high-nickel alloys, "K" Monel combines strength and toughness with resistance to corrosion, abrasion and wear. It withstands unusual stresses and shocks; it resists high temperatures, and the cutting action of gas under pressure. By heat treating, its tensile strength can be developed to 140-170,000 psi, and its hardness to 265-320 Brinell.

As indicated in the typical case histories on this page, "K" Monel has proved its superiority for use under conditions that soon weaken and destroy less rugged metals. Even the sour gas areas of west Texas and New Mexico don't stop "K" Monel!

Additional performance and service records involving "K" Monel and other INCO Nickel Alloys are contained in our illustrated booklet, *Controlling Corrosion in Petroleum Production Equipment.* Designed for easy reading, the booklet has individual sections which deal with exploration and drilling, pumping, and gas control. There's a listing of valuable bulletins and literature that have been prepared for your use, and information telling how you can get free, expert advice on the selection of materials for severe service.

For your copy, write us—today. No obligation, of course.



STOPPED FREEZING in high-pressure well. Surface pressure dropped to 1,350 psi when bottom hole regulator of "K" Monel was installed at 4,000 feet in well that would make gas only on ⅛" surface choke with 3,000 pounds pressure. Freezing stopped. Gas-oil ratio improved. Regulator produced 869,839 bbls. of oil in 57 months, was still in excellent condition when removed for inspection.

ON JOB OVER 8 YEARS. This string of "K" Monel sucker rods has been in continuous use in the Howard Glasscock Field at Big Spring, Texas, since 1941. Before changing to "K" Monel, operator had to contend with a rod break every 50 days, and had to replace the entire string every 5 months.

COMPARE! The "K" Monel drop valve (left) was taken from service after 14 months' contact with corrosive crudes, salt water and hydrogen sulfide. Compare its condition with that of the steel ball, used only 5 days in the same well.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE INCO TRADE MARK

"K"® MONEL *YOUR PARTNER IN PROGRESS*

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For Steady, Economical Pumping

Century Splash Proof Type SCT squirrel cage motor on an oil field pumping rig.

SPECIFY Century TYPE SCT

Protected MOTORS

Century Type SCT "high slip" pumping unit motors save wear and tear on equipment. This high slip characteristic permits the motor to slow down as the load comes on. This cushions the impact of the peak load and minimizes the sudden shock to both motor and equipment.

Century Splash Proof Motors assure continuous production in any kind of weather.

Thousands of Century splash proof motors have been operating, out in the open, in rain, snow, sleet and ice, since their development 15 years ago.

They are widely used for the operation of oil well and irrigation pumps, cooling towers, river lock and dam installation and where the equipment is regularly washed down, etc.

Century builds a wide range of motors for oil producing, refining and distributing. Specify Century for all your electric power requirements.

See your nearest supply store for complete information.

CENTURY ELECTRIC CO.
1806 Pine St., St. Louis 3, Mo.
Offices and Stock Points in Principal Cities

Century C MOTORS

657

Century GENERATORS—

Where public service current is not available, Century Generators will provide adequate, continuous electric power. Depending on the load per motor and the size of generator, from 10 to 30 wells can be operated from one generator. They provide a dependable source of oil field power.

SENSATIONAL New Threading Attachment for LEHMANN LATHES!

PATENT APPLIED FOR

Tool Joint 4¾" Diameter, 5 Pitch Thread 4" Long

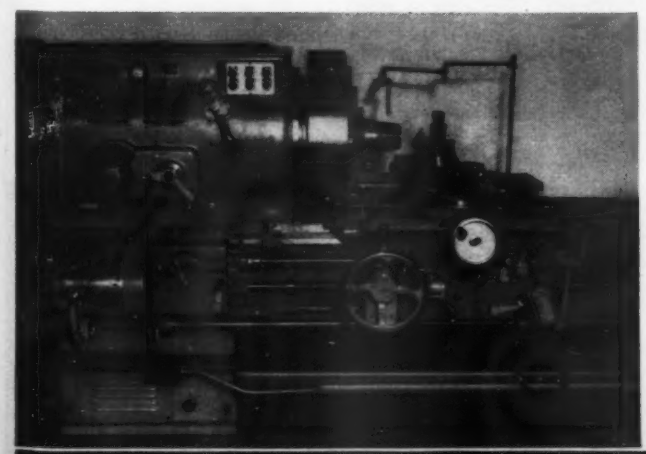
Blindfolded, Inexperienced Operator Threads 4" Oil Field Tool Joint to A.P.I. Standards, *in 15 minutes!*...

Yes, this amazing new Threading Attachment for LEHMANN LATHES will definitely reduce your threading time. It will disengage and stop tool at the same place, no matter what the speed, and close to a shoulder without thread relief and with perfect safety.

The LEHMANN Threading Attachment automatically and simultaneously disengages half nuts, and backs out tool on contact with automatic stop. It can be set for external or internal threads, for right hand or left hand threads, and for straight or tapered threads. In short, it enables an inexperienced operator to equal the speed of an expert.

Write Today for Prices and Full Description

• • •



25-inch HYDRATROL Oil Field Lathe with LEHMANN Threading Attachment.

CHOUTEAU AT GRAND • ST. LOUIS 3, MO.

LEHMANN MACHINE COMPANY

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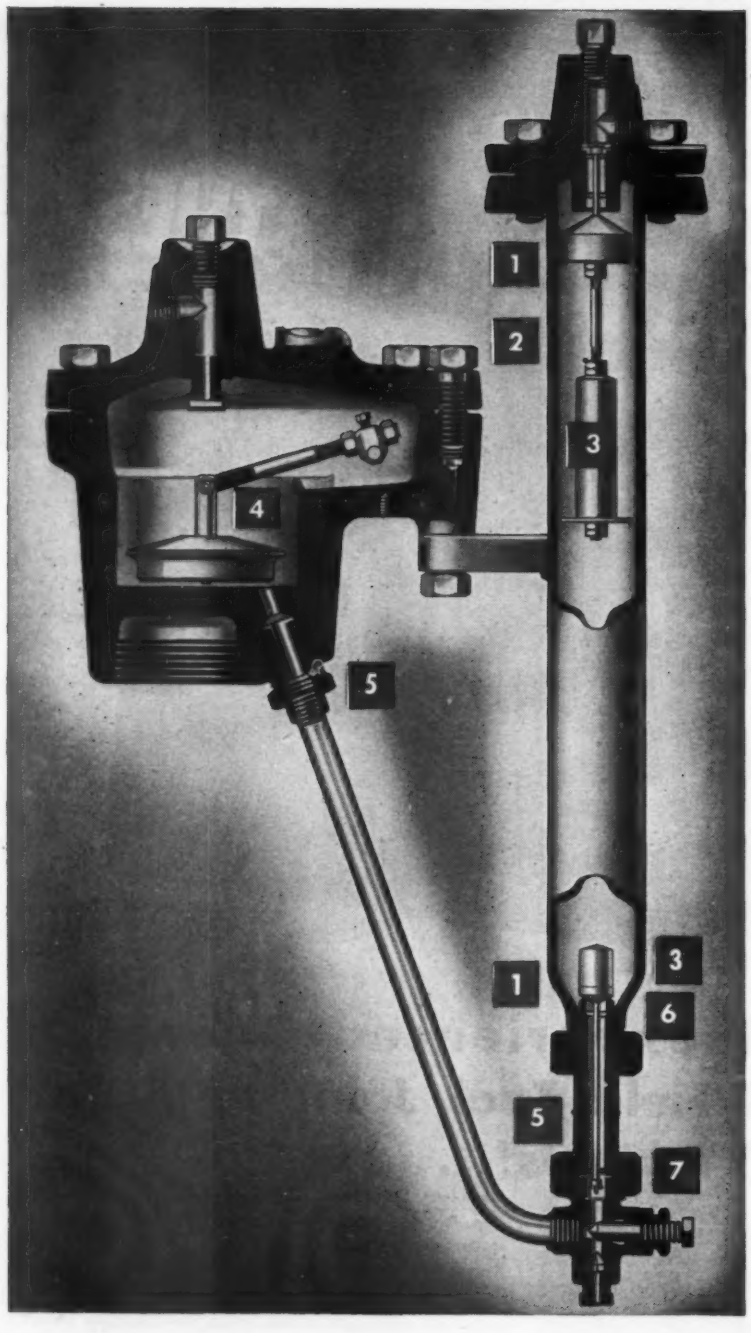


A NEW O
for 1500 p

1 **New Mercury Check Valves Stainless Steel Seats**

2 **Extended Hi-Side. Prevents Loss of Mercury on Reverse Flows**

3 **Plastic Check Valve Floats**

4 **Float in Low Side for Convenient Adjustment**

5 **Union Type Connections for Interchangeability of Range Tubes**

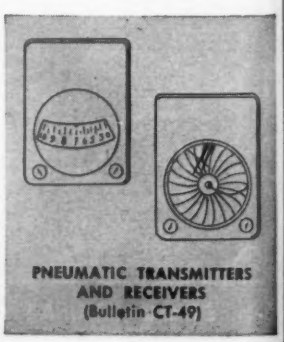
6 **Swaged Hi-Side Tube**

7 **New Pulsation Dampener**

HIGH PRESSURE IRONCASE METERS
(Bulletin EG-40)

RELIANCE CBVA MOTOR VALVES
(Bulletin 50-A)

DRY TEST METERS
(Bulletin AG-3)



PNEUMATIC TRANSMITTERS AND RECEIVERS
(Bulletin CT-49)

ORIFICE METER

p.s.i. Working Pressure

Among the important operating and service improvements embodied in the American METRIC A-88 Series Orifice Meters are the following:

The mercury float is in the low side chamber, which permits cleaning and calibration with low side cover removed

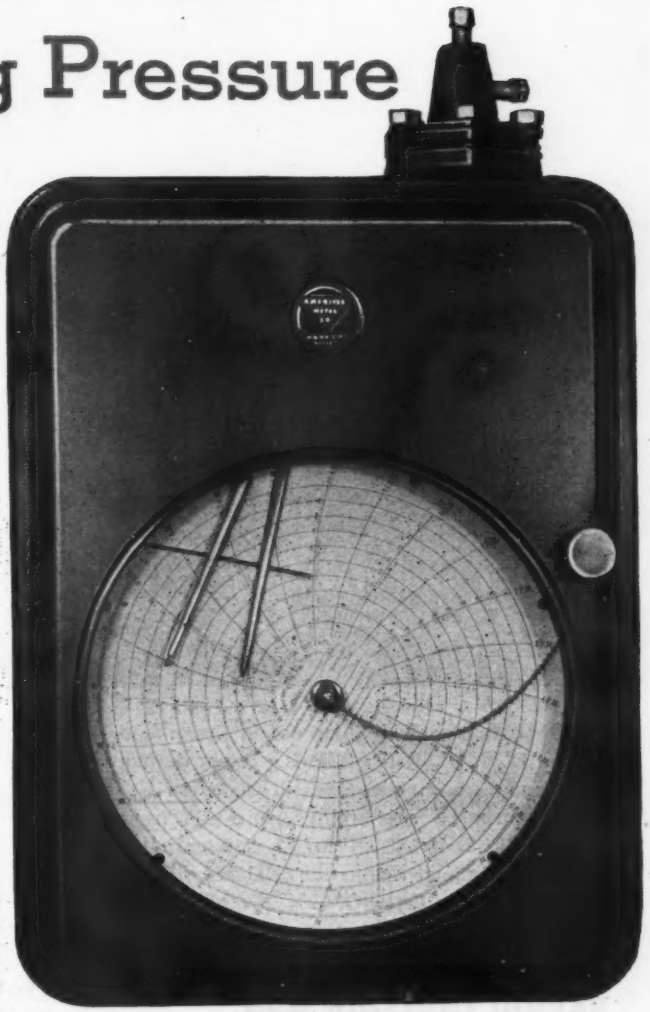
Union type seal tube connections permit interchanging 20", 50", 100" and 200" ranges. Other ranges up to 800" available

Over-range protection is provided by submerged check valve with long guided stem and stainless steel seat

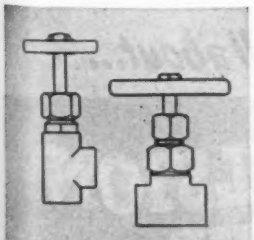
Under-range protection is provided by check valve with stainless steel seat and plastic float in extended high-side chamber

A new Teflon sealed stuffing box with monel shaft requires no grease or other lubrication furnished upon request

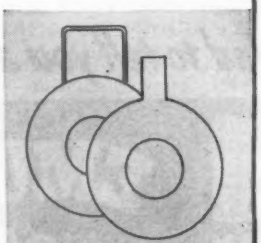
A-88 Series Orifice Meters will handle tough measurement problems. They are rugged, yet simple. They are particularly suitable for applications which must function properly where service inspections may be few and far between. They maintain the American Meter Company tradition of "*sustained accuracy at lower cost.*" Write for Bulletin.



American Meter Company
RECORDING ORIFICE METER
Diff. Range Inches of Water 10—20—50—100—200
Pressure Springs available for all applications



NEEDLE VALVES, SCREWED AND UNION BONNET
(Specification Sheet)



ORIFICE PLATES AND ORIFICE FLANGES
(Bulletin EG-2)

AMERICAN METER COMPANY
INCORPORATED (ESTABLISHED 1836)

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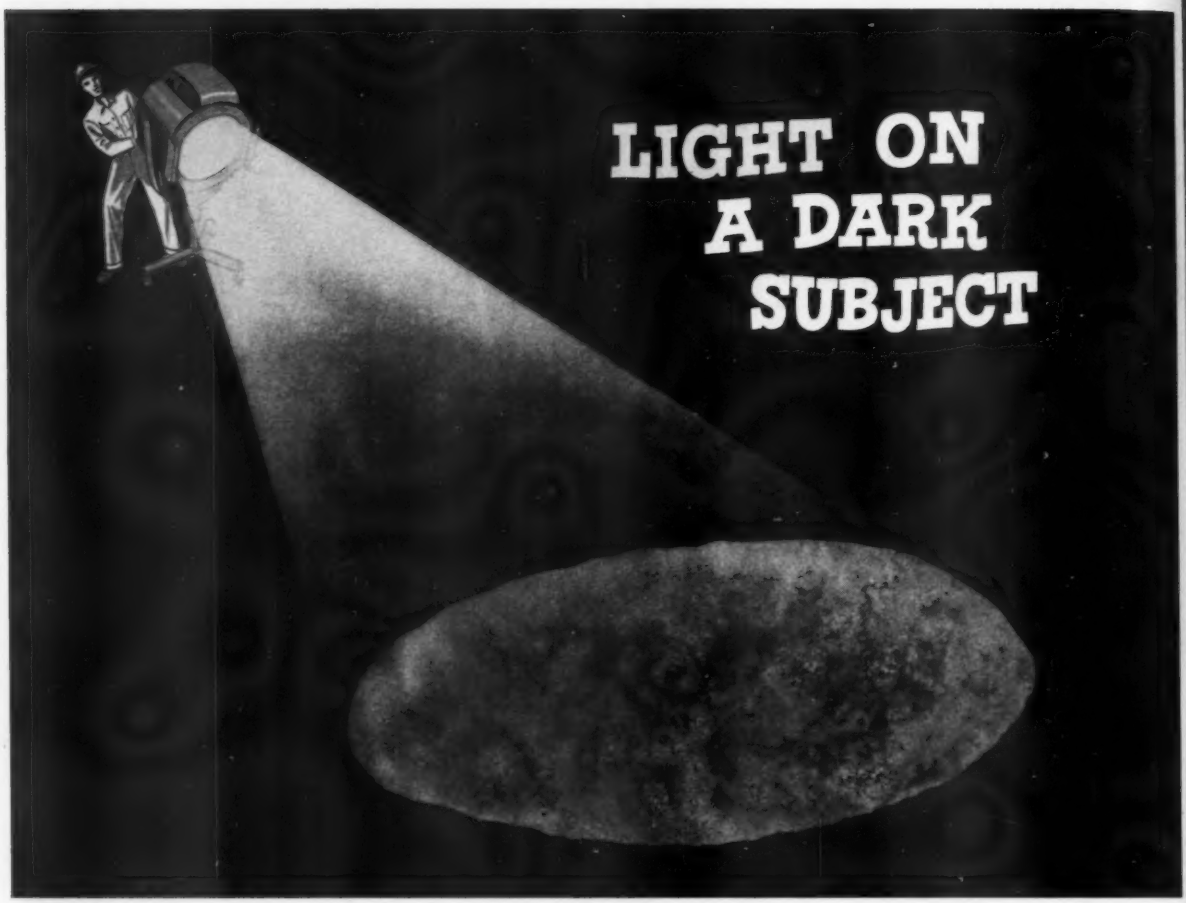
Philadelphia • Pittsburgh • San Francisco • Tulsa
In Canada—Canadian Meter Co., Ltd., Hamilton, Ontario

XUM



Although it is in regular use in many fields, BAROID EMULSION MUD is a recent development, and many operators are still somewhat in the dark about it. So here, briefly, are its high lights.

BAROID EMULSION MUD is essentially a high-*p*H-lime mud with crude or Diesel oil emulsified therein by CARBONOX. Weight and gel materials, such as Baroid, Aquagel and Impermex, may be used as with a normal clay-water mud.

BAROID EMULSION MUD

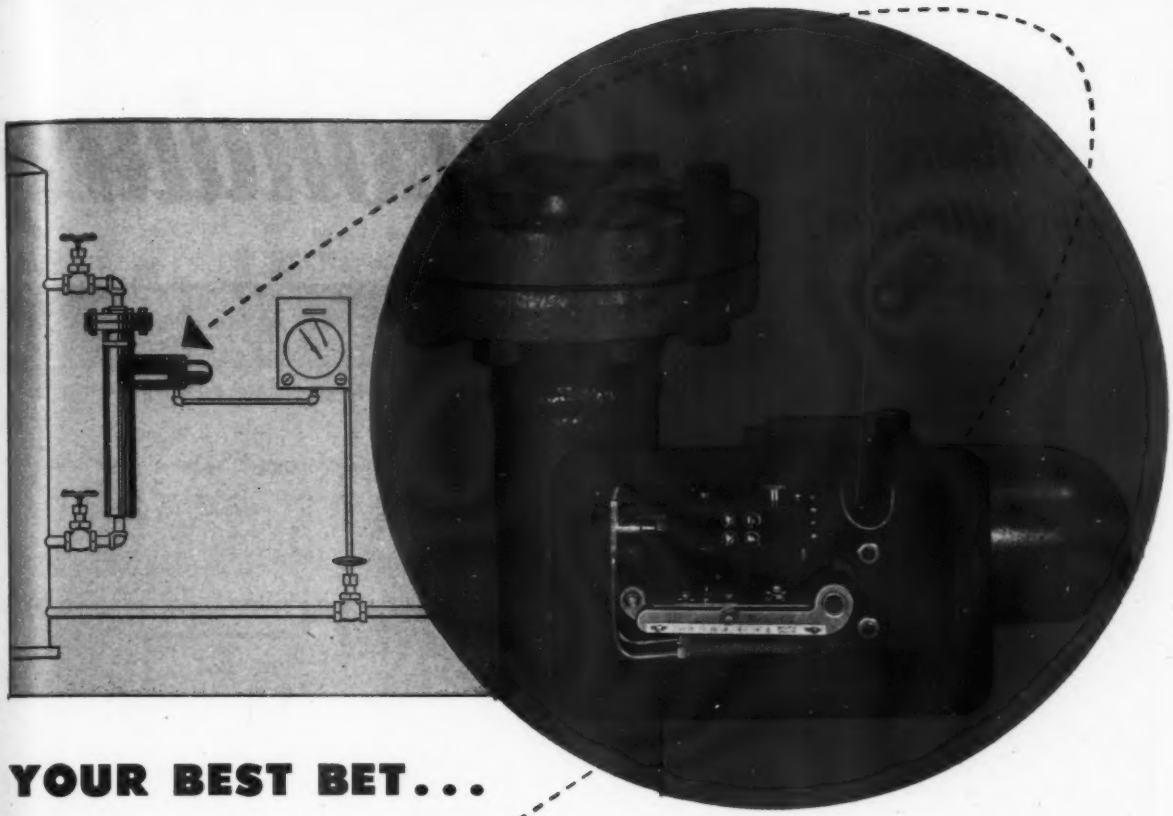
1. ***Resists Contamination*** by gypsum, anhydrite, salt or cement.
2. ***Resists High Temperatures*** met in deep drilling.
3. ***Has Low Water Loss***—as low as ½ cc. API, if desired.
4. ***Is an Excellent Lubricant,*** reducing drill pipe torque and increasing rock bit bearing life.
5. ***Is Stable.***
6. ***Is Easily Maintained.***
7. ***Is Adaptable*** to a wide range of drilling conditions.
8. ***Is Easily Mixed.***
9. ***Is Not a Fire Hazard.***
10. ***Washes Off Easily***

...and you can easily convert your present clay-water mud to Baroid emulsion mud

Your Baroid Service Man will be glad to tell you all about...

Baroid
BAROID SALES DIVISION
NATIONAL LEAD COMPANY
LOS ANGELES 12 · TULSA 3 · HOUSTON 2

EMULSION MUD



YOUR BEST BET...

For Liquid Level Measurement In Continuous Processes...

THE HONEYWELL DISPLACEMENT-TYPE TRANSMITTER

TODAY'S continuous processes demand the type of liquid level measurement best provided by this Honeywell Displacement Type Transmitter. Its outstanding features include *unusual sensitivity* (1 part in 5,000), *friction-free design* and *high speed response* (less than 5 seconds, full range).

It affords dependable measurement of many different liquids (Sp Gr 0.3 to 2.0) without changing parts... unaffected by ambient temperatures and vibration. Neither purge nor liquid seals are required. It is easy to clean. It is available in nine operating ranges for level measurements from 0" to 120"... with connections to suit all usual process vessels. It may be connected to any pneumatic receiver... indicator, recorder or controller... and operates with a full range of transmitted air pressures from 3 to 15 psi.

For more detailed information about this transmitter, call in your local Honeywell engineer... he is as near as your phone! MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 1906 Windrim Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

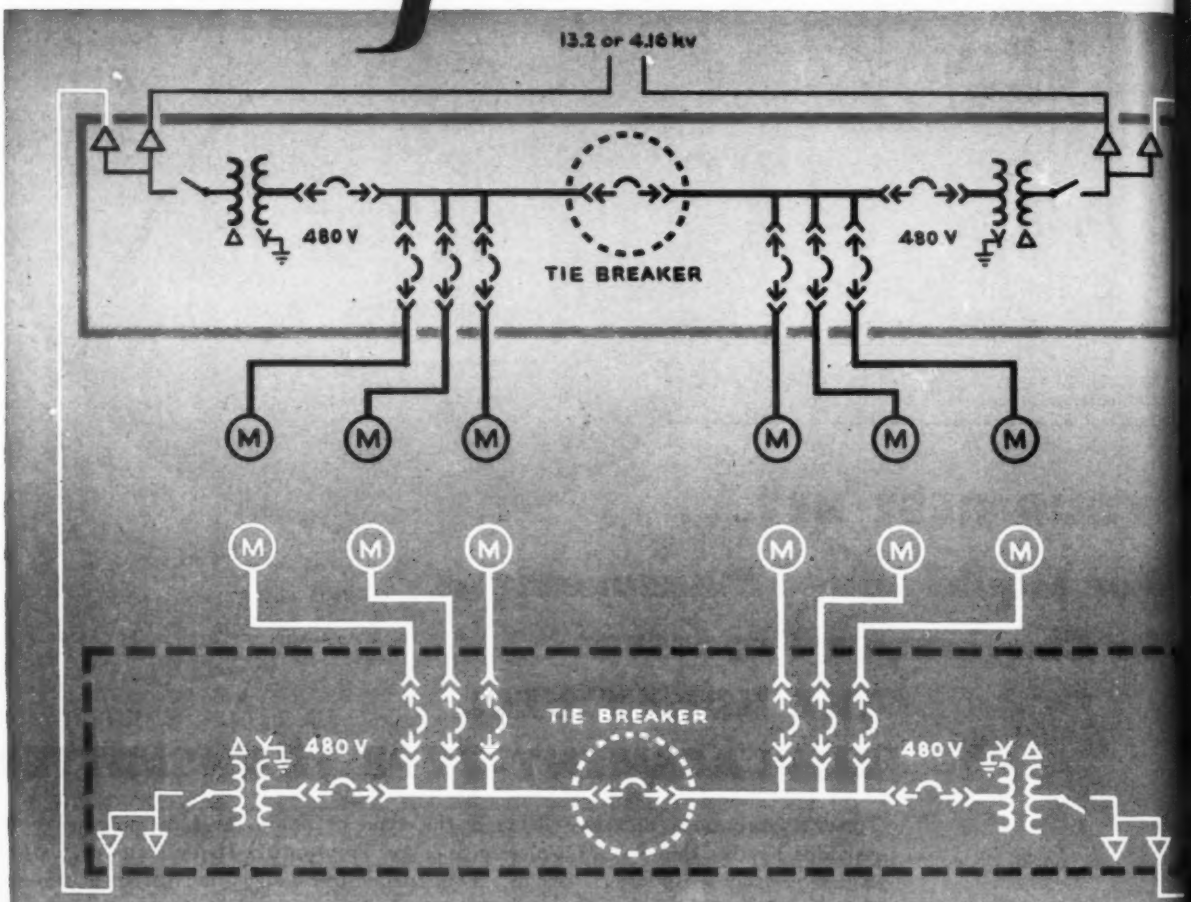
MINNEAPOLIS **Honeywell**

VALVE PRODUCTS

XUM

What's the trend in refinery electrification?

secondary



As this one-line diagram shows, the heart of a secondary selective system is a double-ended unit substation or a pair of single-ended unit substations with a normally-open tie circuit breaker between them. Note how easily the system is expanded by adding more units, either single-ended or double-ended (as shown in white) without requiring new secondary switchgear on existing units. The neutral of the 480-volt system may be grounded for greater service continuity, increased safety, and lower-cost operation.

Here's what you need to modernize your power system!

WHEN YOU COME TO GENERAL ELECTRIC you get far more than the finest in electrical equipment. A General Electric application engineer, familiar with refinery practices, is at your disposal. If desired, he stands ready to assist you in co-ordinating all the needed components, engineering your power distribution into one modern, efficient system.

XUM

selective distribution systems

WITH UNIT SUBSTATIONS

—to protect continuity of service at minimum cost

What's behind the growing refinery practice of distributing power through secondary selective systems? Primarily it's recognition of the fact that for most plants it provides a simple, low-cost way to safeguard service continuity for operations requiring uninterrupted production.

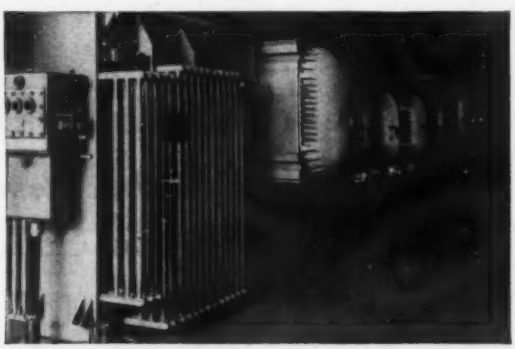
This method utilizes a normally-open tie circuit breaker between the secondaries of two transformers in a double-ended unit substation. The tie provides an alternate source of power for secondary circuits if either transformer becomes de-energized by a fault in the primary circuit. In effect, it enables one "partner" when necessary to carry the essential load.

Simplicity is another advantage of this system. Operating personnel need no special training to operate and maintain the equipment contained in a double-ended unit substation—chiefly transformers and manually-operated drawout air circuit breakers.

Moreover, expansion is easy and economical. Single-ended or double-ended substations can be added at will. Since no added interrupting duty is imposed, no new secondary switchgear is needed on existing units. Full data is contained in Bulletin GET-1438, "Secondary Networks for Industrial Plants." Send for your copy today. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

TO HELP CUT YOUR POWER DISTRIBUTION COSTS . . . Don't miss seeing the "More Power to America" full color and sound slide-film "Modern Industrial Power Distribution." It's packed with helpful, cost-cutting ideas you can use. Ask your G-E representative to arrange a showing for your organization.

G-E double-ended load-center unit substations for non-hazardous areas are compact, factory-assembled "packages." Shipped ready to install, they are furnished in flexible combinations of incoming-line and secondary-circuit arrangements with transformers from 100 to 2000 kva.



For semi-hazardous areas, G-E double-ended load-center unit substations have easily removable air circuit breakers, each in Class I, Group D enclosures, plus primary power circuit breaker, a standard Pyranol® transformer section, and a secondary bus enclosure.

GENERAL ELECTRIC

661-12

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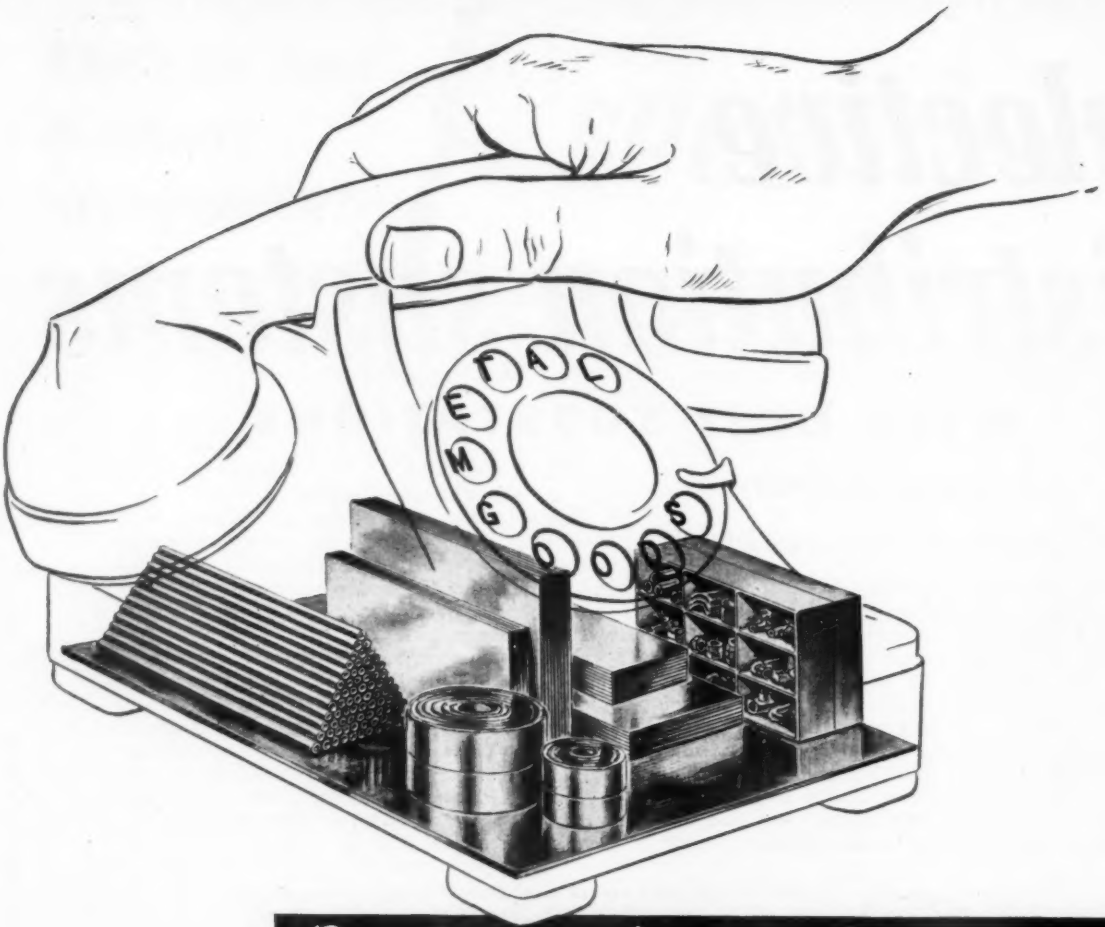

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Sheets • Tubes • Plates • Bars • Fittings • Accessories

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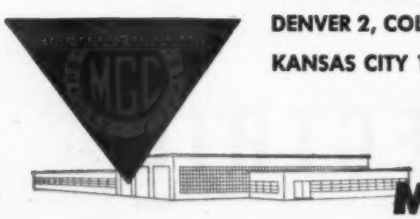


METAL GOODS CORPORATION

The Simplest, EASIEST counterweight adjustment ever devised for pumping units

Easy does it!

One crank setting, one wrench, one man. Note the safety features. The man "keeps his feet on the ground"; he isn't obliged to climb on the unit when shifting counterweights. Nothing to move; nothing to fall and hurt him.

Outer counterweight shell removed. Pinion, rack, and rollers in place.

Bethlehem's Series 50 Pumping Units feature great new improvements in mechanical counterweight adjustment—improvements that top anything of the kind yet offered in the long history of oil-field pumping. They were developed slowly, carefully; they were subjected for many months to the most rigorous field tests, the most brutal we could devise—and they passed every test without a whimper.

We wanted efficient mechanical counterweighting that could be varied *easily* at the will of the operator. We got it. Note the large photograph. After loosening four nuts, the field man can shift the position of a counterweight in a matter of seconds. An easy tug on the wrench will do it—a child can do it! Numbered graduations on the crank, and an index on each outer counterweight shell, facilitate adjustment.

The great ease with which counterweights can be shifted is explained by the smaller photograph. A pinion, turned by the socket wrench, is geared to the crank rack. Smooth, sturdy rollers help to ease the counterweight along the corresponding crank rail.

For many applications, the heavy cast shells alone provide sufficient counterweighting. However, if more is required, counterweight inserts, furnished by Bethlehem, can easily be bolted inside the shells.

The new Series 50 units are already operating successfully at many points in the field. If you'd care to see some of them at work, a Bethlehem man will be glad to arrange it. We want you to study them—and hear their owners' comments!

BETHLEHEM STEEL

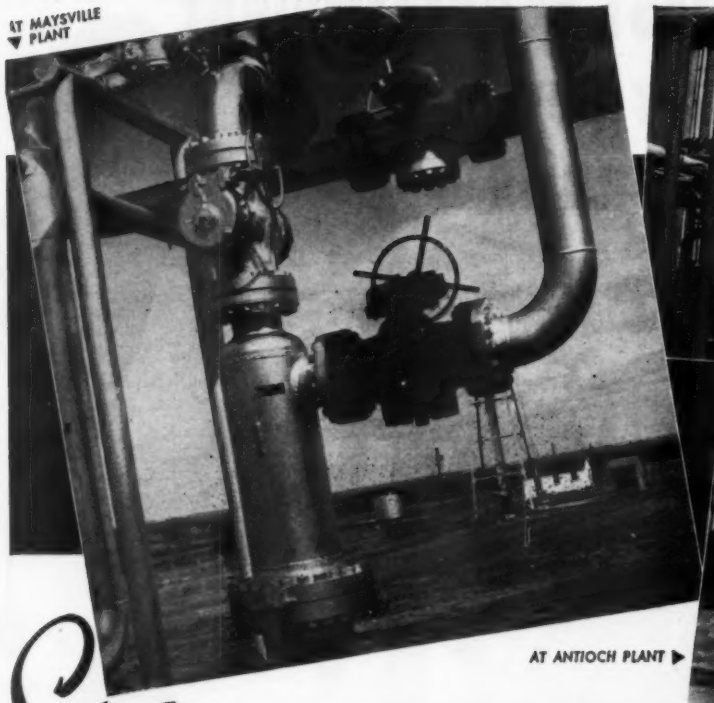
BETHLEHEM SUPPLY COMPANY

GENERAL OFFICES: 21 E. SECOND STREET, TULSA, OKLA.

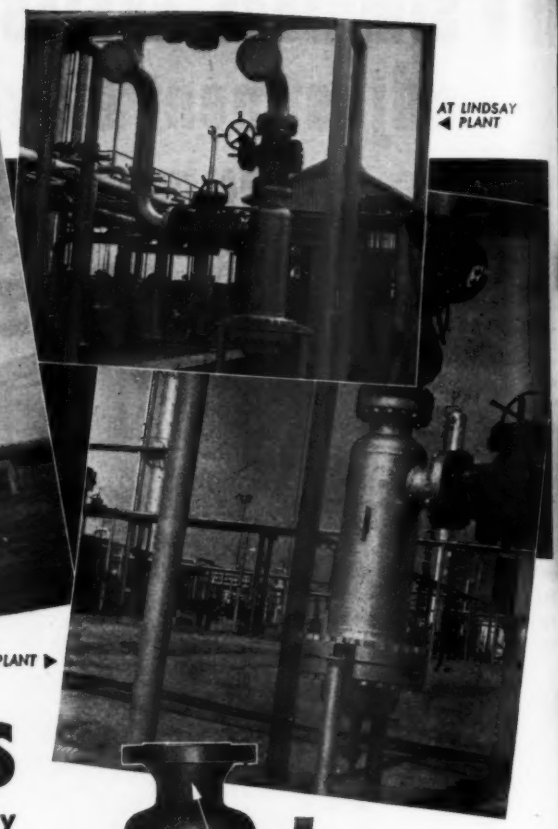
Subsidiary of Bethlehem Steel Corporation

On the Pacific Coast Bethlehem Oil-Field Equipment is sold by Bethlehem Supply Company of California.
Export Distributor: Bethlehem Steel Export Corporation

XUM



AT MAYSVILLE PLANT



AT LINDSAY PLANT

AT ANTIOCH PLANT

Staynew FILTERS

in the New Garvin County Plants Protect Compressors, Prevent Injection Well Plugging!

Here, in one of the newest and largest operations of its kind in the entire world, Staynew Filters provide all-important protection for equipment and processing.

In each plant, a Staynew Model HPH Filter removes aluminum oxide generated in the dehydration process from approximately 40 million cu. ft. of gas per day. This aluminum oxide, in the form of an abrasive powder, would cause serious damage if allowed to pass steadily into the lines and equipment which subsequently handle the gas.

In the Antioch Plant, where dehydrated gas is re-pressured to 2400 lbs. and injected into the reservoir, the Staynew Filter not only positively protects the 3 extra re-pressuring compressors against excessive wear, but prevents the pores of the oil-bearing sand from becoming plugged with aluminum oxide.

All Plants Operate Night and Day the Year Around

Such continuous operation would ordinarily require dual installations. However, due to the exclusive Staynew design, a *single filter* only was required at each plant. A by-pass is provided for use during the time required for cleaning or replacement of inserts. Experience indicates that such servicing is not necessary oftener than twice a year, and that only two hours is required for the operation!

This group of filters represents only one of the thousands of Staynew installations in critical service throughout industry. As a result of the many problems solved during these installations, an unsurpassed fund of information in this specialized field has been acquired. For help in solving *your* filtration problems, contact your Dollinger representative, or write direct, care of Dollinger Testing Laboratory.

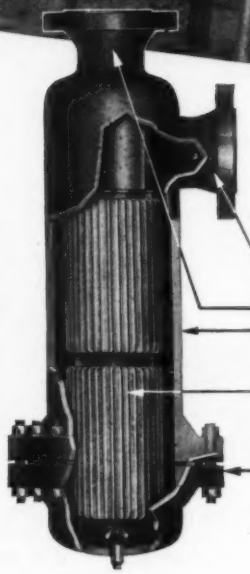


Diagram and Specifications of STAYNEW FILTERS in Service at Garvin County Plants

- **Inlet.**
- **Outlet.**
- **Forged steel shell, ⅞ in. thickness, certified for 800 lbs. pressure.**
- **Radial Fin Filter Inserts. Removable by simply unscrewing wingbolt after unbolting head.**
- **Bolted Head, 32 in. x 3½ in. flanges.**

Wt. 3425 lbs.

DOLLINGER CORPORATION

5 CENTRE PK., ROCHESTER 3, N. Y.

DOLLINGER REG. PROTECTOMOTOR U.S. PAT. OFF. **STAYNEW FILTERS**

use NATIONAL SEAMLESS for less down-the-hole trouble

THE consistently fine records achieved with NATIONAL Seamless Oil Country Goods on successful deep producers indicate almost complete freedom from fishing jobs due to pipe failure! Fewer fishing jobs mean more economical operation and smoother going all the way.

The uniform strength and toughness of every part of every section is mainly responsible for the long and dependable service you get from NATIONAL Seamless Drill Pipe, Casing, and Tubing. For in our method of manufacture, each length of NATIONAL Seamless is pierced from a billet of high quality steel. This piercing operation—one of the most drastic operations in the forging industry—demands the very best steel. The finished product is absolutely free from any longitudinal weld which means uniform wall strength throughout.

WALLS WITHOUT WELDS

For more information on NATIONAL Seamless Drill Pipe, Casing, and Tubing, write National Tube Company, Frick Building, Pittsburgh, Pennsylvania. Ask for Bulletin No. 15.

• • •

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
UNITED STATES STEEL EXPORT COMPANY NEW YORK

USS

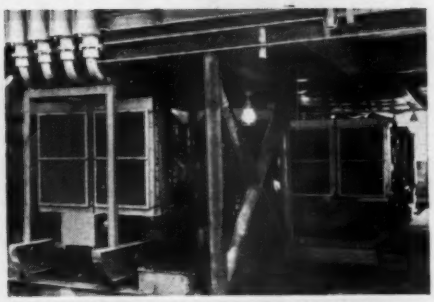
NATIONAL SEAMLESS
drill pipe . . . casing . . . tubing

UNITED STATES STEEL

XUM

100% GM DIESEL-POWERED

3 GM Series 71 Diesel "Twins" power Emsco J-750 draw works.



2 GM Diesel "Quads" under derrick floor drive Gardner-Denver 8" x 20" mud pumps.

2 GM Diesel "Sixes" in "dog house" power 60 KW generators.

More Power–Less Weight –Less Space–Easier Moves

SIXTEEN General Motors Series 71 Diesel engines—3 "Twins" on draw works, 2 "Quads" on mud pumps and 2 "Sixes" on generators—power this Rocky Mountain Drilling Company rig, shown drilling in Pico Canyon, California.

GM Diesels were chosen because their efficient 2-cycle operation makes them lighter and smaller with no sacrifice of ruggedness or power. They are compact as well as dependable, portable as well as powerful, smooth as well as economical.

Each single "Six" delivers a sturdy, continuous 130 BHP at 1600 rpm. Each "Twin," two sixes geared side by side, turns out 260 BHP, and four sixes form a "Quad" which provides 520 continuous BHP.

Any of these units is readily compounded for deep-well drilling. In this multiple-engine setup, for example, a full 2100 HP is available for the pumps if necessary. And any engine can be shut down while the others continue to operate.

Easy to see, isn't it, why more and more operators are turning to this modern, flexible Diesel power? They get started fast, keep going steadily and can be easily and quickly moved when the time comes. *Let us give you all the facts.*

SEE OUR CATALOG in the COMPOSITE CATALOG

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES... Up to 275 H.P. **DETROIT 28, MICHIGAN** MULTIPLE UNITS... Up to 800 H.P.

GENERAL MOTORS

GM GENERAL MOTORS DIESEL POWER

DIESEL BRAWN WITHOUT THE BULK

GENERAL MOTORS CORP., DIESEL ENGINE SALES, PETROLEUM INDUSTRY, 1504 Philtower Bldg., TULSA 3, OKLAHOMA

CALIFORNIA: Anderson-O'Brien Co., LOS ANGELES 21; Lawless Brothers, BAKERSFIELD; West Coast Engine & Equipt. Co., BERKELEY. **ILLINOIS:** Western Machinery & Engine Co., CENTRALIA. **KANSAS:** Diesel Equipment Co., Inc., WICHITA. **COLORADO:** Colorado Builders' Supply Co. (Equipt. Division), DENVER. **LOUISIANA:** George Engine Co., Inc., HARVEY; United Tool & Valve Repair Co., SHREVEPORT. **MISSOURI:** Western Machinery & Engine Co., ST. LOUIS 10. **MONTANA:** Seitz Machinery Co., Inc., BILLINGS; Mountain Tractor Co., MISSOULA. **OKLAHOMA:** Diesel Power Co., OKLAHOMA CITY. **TEXAS:** Stewart & Stevenson Services, Inc., HOUSTON 1, McALLEN, DALLAS, CORPUS CHRISTI, WICHITA FALLS; Haynes Machinery Co., PLAINVIEW; Empire Machinery Co., Ltd., ODESSA. **WYOMING:** Colorado Builders' Supply Co. (Equipt. Division), CASPER.

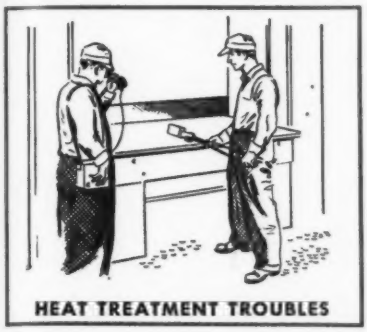
MISSISSIPPI: Taylor Machine Works, Jackson.

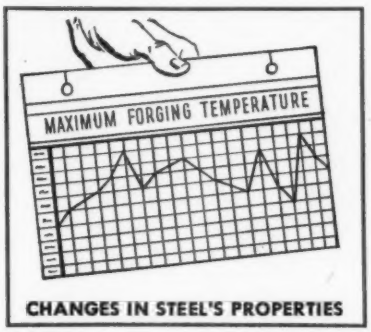
6 forge shop problems with 1 answer

REJECTS

DELAYS

SHOP-PRACTICE CHANGES


HEAT TREATMENT TROUBLES



CHANGES IN STEEL'S PROPERTIES

VARYING PRODUCT QUALITY

—TIMKEN® forging steels!

BECAUSE Timken® forging steels have outstanding *uniformity,* they help you lick the tough forge shop problems shown above.

From bar to bar and heat to heat, Timken forging steels give you uniformly superior surface and internal quality, uniform forgeability, uniform physical properties and uniform response to heat treatment.

These qualities result in: (1) reduced production costs—through fewer rejects, delays and shop-practice changes, (2) uniform high quality in your finished forgings.

That's true no matter what analysis you use, because quality is *completely* controlled by The Timken Roller Bearing Company—from melting through final inspection. What's more, it's *advanced* quality control, resulting from many special mill practices developed by years of research in alloy steels.

For help in making better forgings at less cost, write today. Ask also for our 112-page book of authoritative forging data, "Evaluating the Forgeability of Steels." The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing.

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engineered to bring you the finest in medium speed

packaged diesel power

...the New ENTERPRISE M SERIES Stationary Diesels

If you want 68 to 240 BHP, you'll get more for your money with an Enterprise 3, 4, or 6 cylinder M Series Diesel

- 8" bore x 10" stroke
- Compact, light weight
- Easy starting, air or electric
- Operate on wide variety of low cost fuels
- Extremely low fuel consumption
- Smooth, quiet, clean operation
- Front and rear end power take-offs

Write for new Enterprise M Series Bulletin No. M-16, or call your nearest Enterprise office for complete information.

Everything you want in efficient stationary power is wrapped up in the all-new M Series packaged power plants. Designed and developed to meet the demand for tough and continuous operation at medium speeds, these completely self-contained diesels in 3, 4 and 6 cylinder models are now available for the most economical solution to your industrial power needs. Small, compact, light weight, portable if desired, these units deliver 68 to 240 BHP at conservative speeds of 450 to 750 RPM. They are WORK engines, capable of thousands of hours in demanding service, at low cost, with minimum maintenance and servicing requirements. When you compare, feature for feature, you're sure to make your next diesel a medium speed, high capacity Enterprise M engine—for years of the smoothest power you've ever enjoyed.

E ENTERPRISE

Enterprise STATIONARY Diesels

ENTERPRISE ENGINE & FOUNDRY COMPANY

18th & Florida Streets, San Francisco 10, California Offices in Principal Cities

VESSEL DIVISION

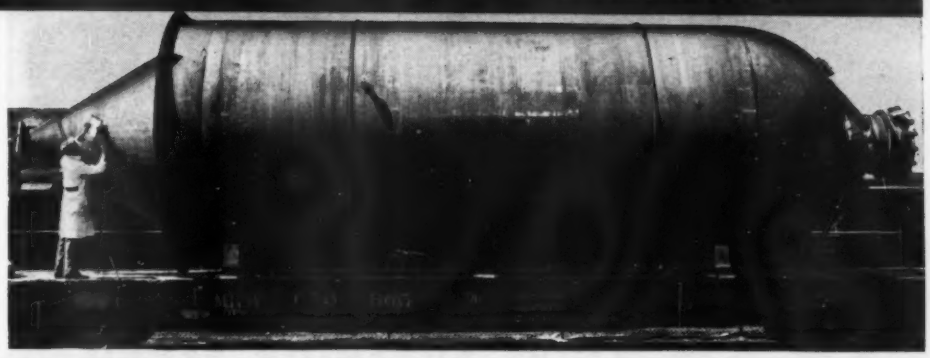
NEWS

SMITHWAY 76th ANNIVERSARY 1874 - 1950

A.O.Smith CORPORATION

Atlanta 3 • Boston 16 • Chicago 4 • Dallas 1 • Houston 2
Los Angeles 14 • New York 17 • Philadelphia 3 • Pittsburgh 19
Salt Lake City 1 • Seattle 1 • Tulsa 3 • Washington 6, D.C.
International Division: Milwaukee 1

VESSEL LIFE INSURANCE. Before this SMITH-lined Paper Mill Digester was manufactured, an extensive and comprehensive testing program was completed to be sure the proper alloy lining was selected for the corrosive service. An experimental digester was built and a great many "cooks" were run before the final decision was made.



USING A. O. SMITH MULTI-LAYER CONSTRUCTION WAS MORE ECONOMICAL than single-plate construction in the manufacture of this 72 in. dia. by 80 ft. long water scrubber, at the same time providing a safer construction.

FIELD ASSEMBLY COSTS CUT TO A MINIMUM. The SMITHway is to do the maximum amount of work possible in the shop on vessels too big to be shipped in one piece. All the shell courses on this 15 ft. dia. by 113 ft. long A. O. Smith Atmospheric Tower were tacked together in the shop to get more accurate and complete installation of the internals.

CONSISTENT QUALITY OF A. O. SMITH ELECTRODES used in the manufacture of A. O. Smith Pressure Vessels is preserved by meticulous control procedures. By means of this X-ray diffraction machine, all raw materials used in electrode coating are checked for the presence of any foreign materials or impurities.

A. O. Smith Corporation, Dept. OG-750 Milwaukee 1, Wisconsin

Without obligation, send us the latest A. O. Smith Vessel Bulletins:

- ☐ V-44: Field Assembly of Pressure Vessels
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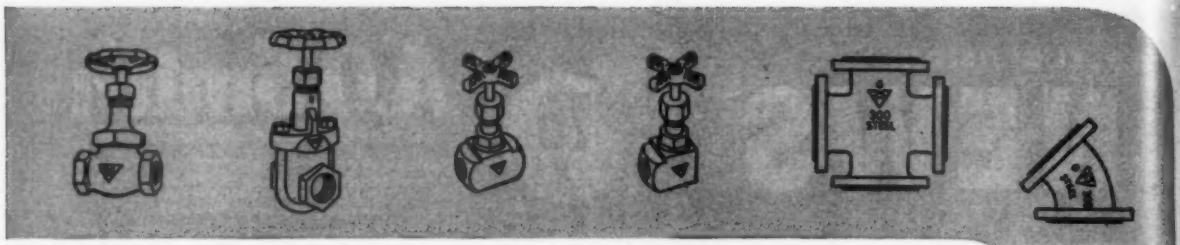
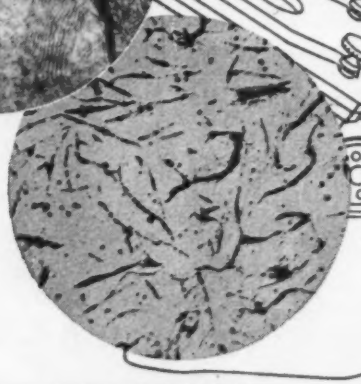


THE MICROSCOPE SHOWS WHY

R·P&C Electric Iron Valves

GIVE SUPERIOR SERVICE

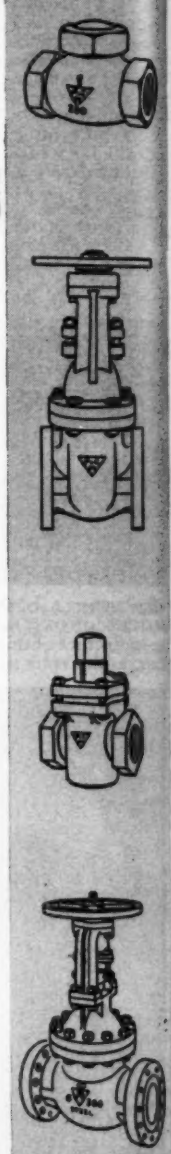
PEARLITIC MATRIX
MAGNIFIED 500X—shows the sound banded structure of the base from which the desirable physical characteristics come.



GRAPHITE FLAKES
MAGNIFIED 100X—fineness of graphite flakes minimizes possibility of weak spots—results in stronger iron.

CLOSE ANALYSIS CONTROL
—possible in the electric furnace—results in a pearlitic matrix, evenly distributed graphite, minimum sulphur and phosphorus, superior iron, sound castings, high quality valves. All R-P&C IRON VALVES are made of Electric Cast Iron.

Ask your R-P&C Distributor for copies of these Bulletins DH-8 and DH-136 which describe in more detail the R-P&C line of Iron Valves



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Reading, Pa., Atlanta, Baltimore, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

R-P & C VALVE DIVISION
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READING-PRATT & CADY VALVES

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TRACKSON
PIPE LAYERS...
TOP HANDS
OF THE PIPE LINE GANG!

Your choice of pipe handling equipment can mean the difference between a profit or a loss . . . that's why TRACKSON PIPE LAYERS are "top-hands" on profitable pipe line gangs!

These rugged performers have the lifting capacity, the speed, the precision control so necessary for efficient, time-and-money-saving handling of pipe. Even with the heaviest lifts, operators have sure, accurate command of every operation. Five models of TRACKSON PIPE LAYERS make available a size for every pipe line need — and each is designed and built to make full use of the power and capacity of its matching size of "Caterpillar" Diesel Tractor.

There are other TRACKSON Tractor tools to aid the pipe liner — TRAXCAVATORS, for all types of excavation, loading and material handling; ANGLEFILLERS for fast, economical backfilling and miscellaneous dozer work. Your TRACKSON-"Caterpillar" Dealer has more interesting information that can help you choose profits! See him, today, or write to TRACKSON COMPANY, Dept. OG-70, Milwaukee 1, Wisconsin, U.S.A.

Here's another TRACKSON tool for pipe line profits — the TRACKSON ANGLEFILLER. Used with the PIPE LAYER, this tool can cut costs on all phases of oil and pipeline work. Ask your TRACKSON-"Caterpillar" Dealer!

TRACKSON® TRACTOR EQUIPMENT

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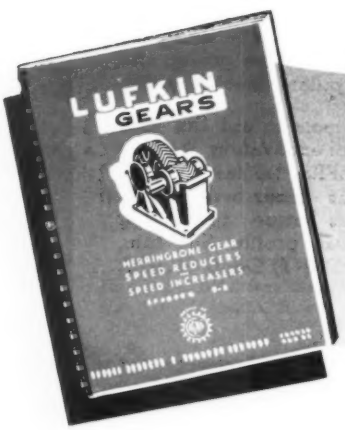
Lufkin for the THRIFTY

...in 1950

Records maintained by long-time users of Lufkin Pumping Un reveal the utmost in economy in operating and maintenan costs . . . the all-important factors in this day. Truly it *"Lufkin for the Thrifty in 1950!"* Our engineers will gladly gi you the Lufkin story. *Call them today!*



Lufkin commercial gear reducers and speed increasers, in all sizes and for all conditions, are available, usually from stock. Send today for our special gear catalog!

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INDUSTRIAL SPEED REDUCERS

DIVISION LUFKIN FOUNDRY & MACHINE COMPANY

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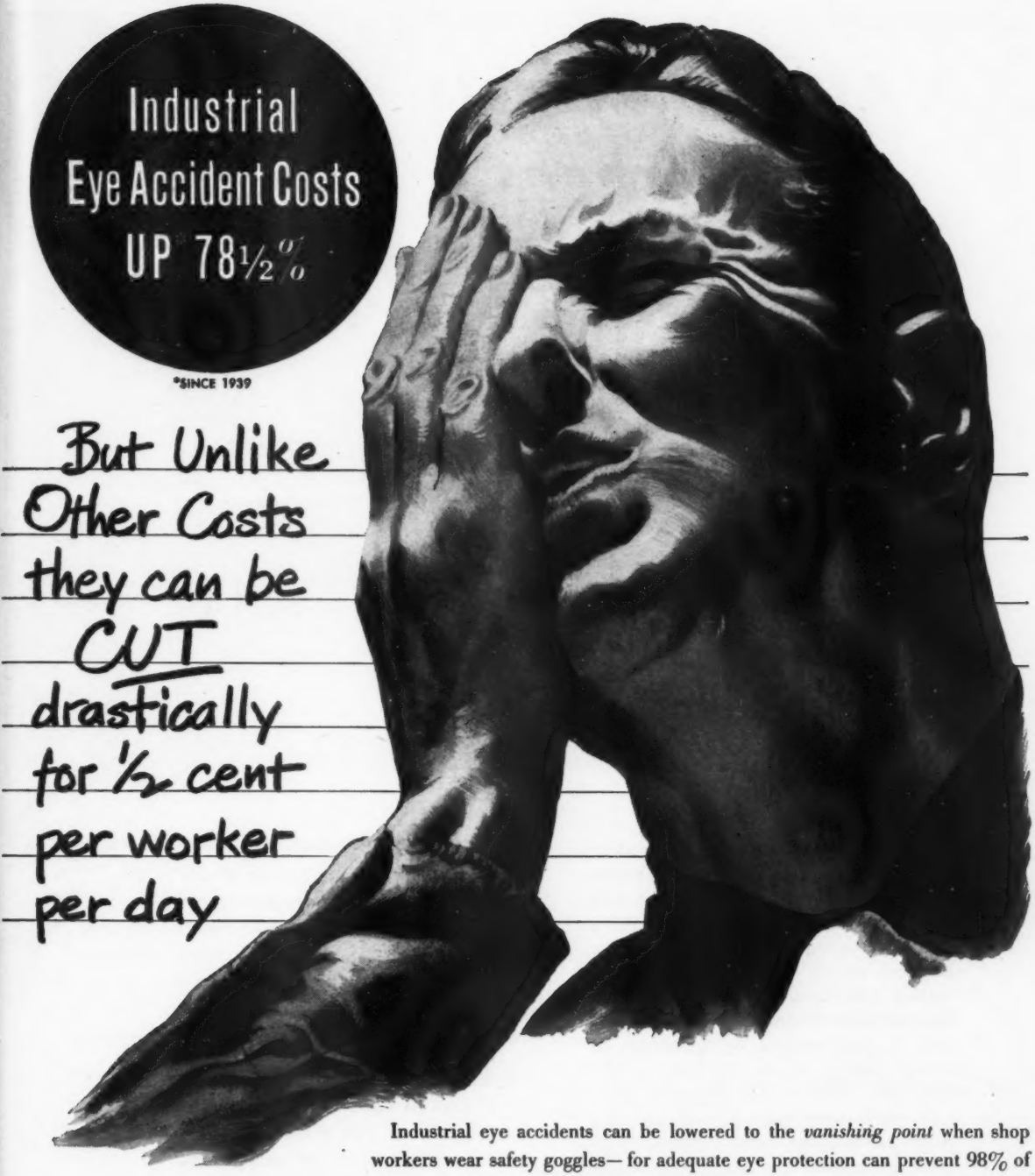
Industrial Eye Accident Costs UP 78½%

*SINCE 1939

But Unlike Other Costs they can be CUT drastically for ½ cent per worker per day



Industrial eye accidents can be lowered to the *vanishing point* when shop workers wear safety goggles— for adequate eye protection can prevent 98% of all eye accidents. With 1949 average hourly earnings estimated at $1.41, a pair of goggles costs less than 2 hours loss of productive time that even a minor eye accident can cause.

Your AO Safety Representative has complete facts as to what an adequate eye protection program SAVES — industry by industry, including *yours*. Ask him to call.

Safety Products Division of American Optical COMPANY

SOUTHBRIDGE, MASSACHUSETTS • BRANCHES IN PRINCIPAL CITIES

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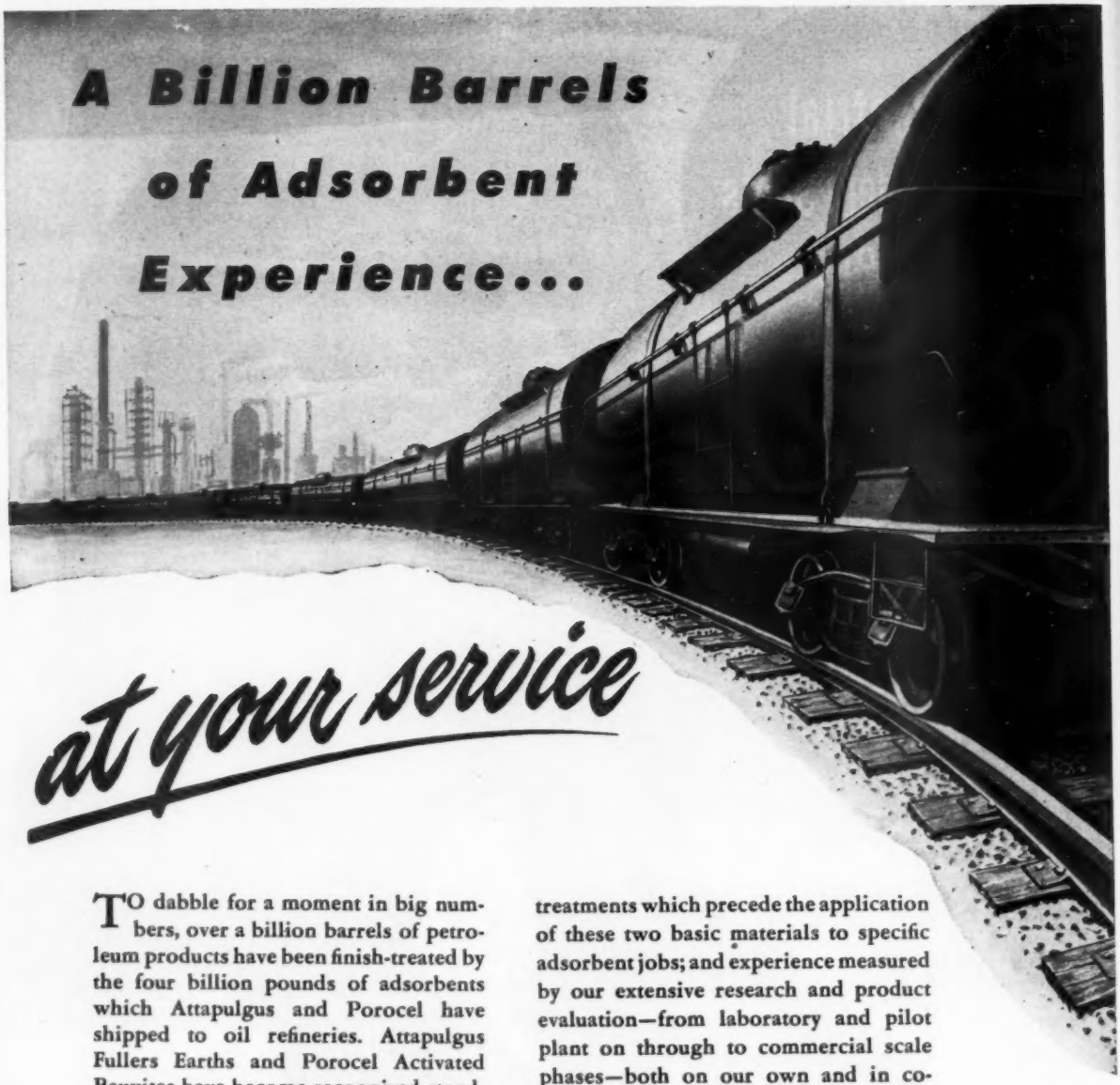


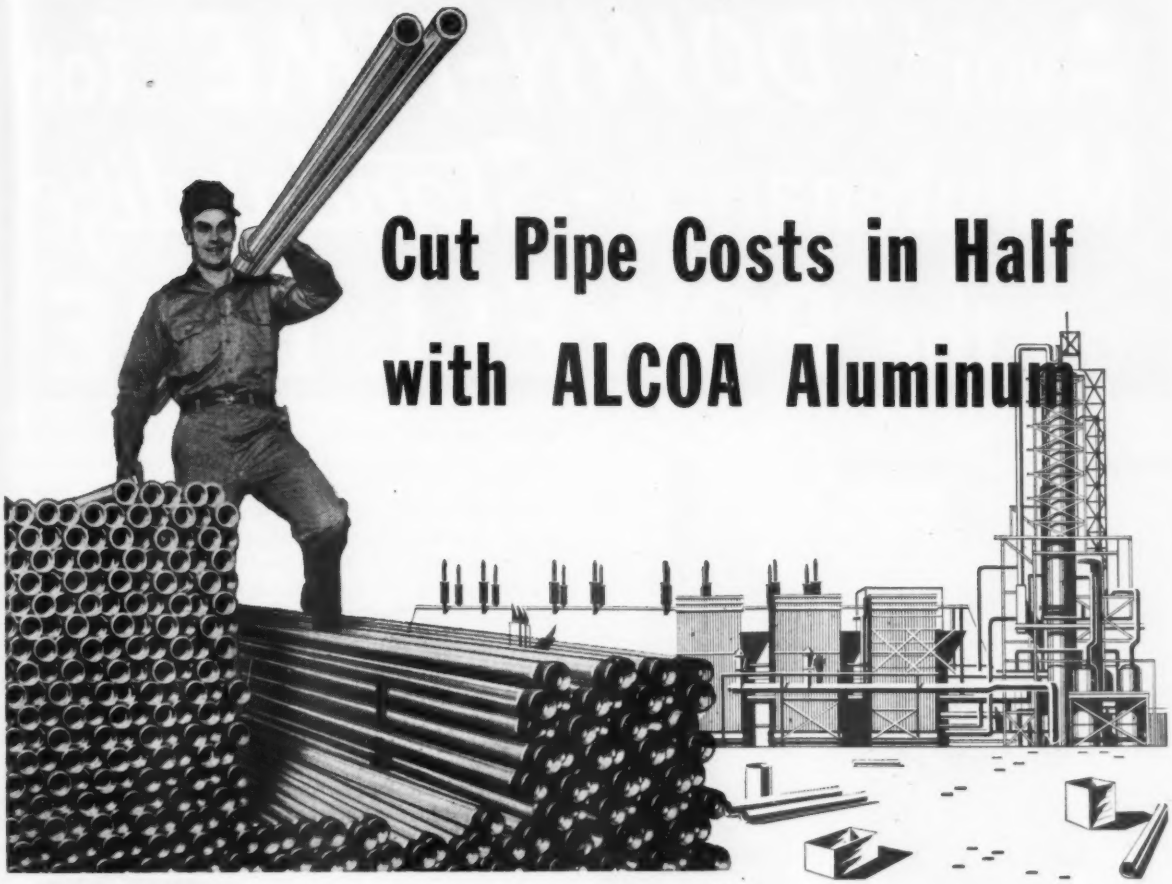
TO dabble for a moment in big numbers, over a billion barrels of petroleum products have been finish-treated by the four billion pounds of adsorbents which Attapulgus and Porocel have shipped to oil refineries. Attapulgus Fullers Earths and Porocel Activated Bauxites have become recognized standards in the removal or reduction of odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates, and for solid catalyst purposes. And in this wide range of services, remarkable finished value was gained in a long list of petroleum cuts—from the lightest distillates to the heaviest lubes and waxes.

This all adds up to a lot of adsorbent experience—experience with the many treatments which precede the application of these two basic materials to specific adsorbent jobs; and experience measured by our extensive research and product evaluation—from laboratory and pilot plant on through to commercial scale phases—both on our own and in cooperation with our customers.

So there's great merit to the suggestion that it pays to consult Attapulgus and Porocel. In your own plans to improve products or expand output, perhaps our one billion barrels of adsorbent experience can be of real help to you in selecting the right adsorbent and the right conditions. Our laboratory and process staff are at your service, without obligation.

ATTAPULGUS CLAY COMPANY *Fullers Earth* · **POROCEL CORPORATION** *Activated Bauxites*

Dept. V, 210 West Washington Square, Philadelphia 5, Pa.



Cut Pipe Costs in Half with ALCOA Aluminum

You can actually save 50% or *more* on pipe when you specify Alcoa Aluminum Pipe in place of other corrosion resistant pipe. Save money on installation, too, because aluminum weighs less.

And get superior corrosion resistance. Alcoa Aluminum 63S Pipe is highly resistant to corrosion by sulfur compounds; safely carries many chemicals, petroleum products, foods, other commodities. Where a high degree of purity and color must be maintained, specify aluminum, because it produces no metal oxides that contaminate the product. The product can't hurt the pipe, and the pipe can't hurt the product.

For local source of Alcoa Aluminum Pipe and other Alcoa Products, look under "Aluminum" in your classified telephone directory.

Alcoa Aluminum Pipe is seamless, and comes in ⅛" to 12" standard pipe sizes. It's easy to join, standard fittings and flanges are available from nationally known manufacturers.

For your nearest supplier, call your local Alcoa sales office (branches in 55 cities) or write ALUMINUM COMPANY OF AMERICA, 1978G Gulf Building, Pittsburgh 19, Pennsylvania.

FREE BOOKLET

Gives you the facts on Alcoa Aluminum Pipe—applications, physical and mechanical properties. Write today for your free copy.

ALCOA ALUMINUM PIPE

ALCOA ALUMINUM

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT-MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS • SCREW MACHINE PRODUCTS • FABRICATED PRODUCTS • FASTENERS • FOIL • ALUMINUM PIGMENTS • MAGNESIUM PRODUCTS

XUM

Avoid "DOWN-TIME" for Maintenance—Standardize on the POWELL LINE

When you buy a valve, ask yourself these two questions. First, will it operate satisfactorily in the service in which it is to be used? Second, and of most importance, how much *maintenance* will it require? Because, every time maintenance becomes necessary, there's a two-fold cost. One, the cost of labor—and possibly parts—to put it back in working order. Two, the loss of production farther down the line.

And, because Powell Engineers *always* have this in mind, every valve in the *complete* Powell Line* is designed and made to avoid, as far as possible, "DOWN-TIME" for maintenance.

That's why, through the years, Powell Valves have been noted for long, trouble-free performance—even under the most exacting service conditions.

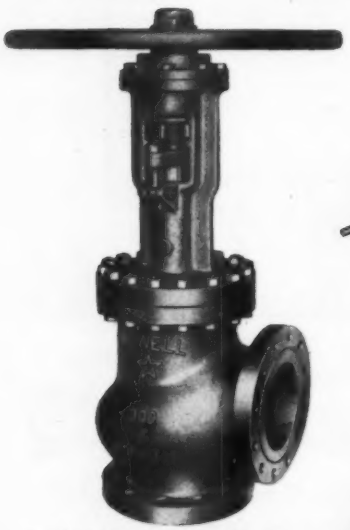


Fig. 3033—Class 300-pound Cast Alloy Steel Angle Valve with flanged ends, outside screw rising stem and bolted flanged yoke. The streamlined areas through the body assure maximum flow with minimum pressure drop. Built to handle temperatures up to 1400 F.

Fig. 6079—(Motor Operated) Class 600-pound Cast Steel Gate Valve for Pipe Line Service. Has flanged ends and bolted flanged bonnet. Classes 150, 300, and 400-pound valves can be furnished. Also available with gears.

Fig. 375 — 200-pound Bronze Gate Valve. Screwed ends, union bonnet, inside screw rising stem and renewable "Powellium" wear-resisting nickel-bronze disc.

Fig. 1793 — Large 125-pound Iron Body Bronze Mounted Gate Valve with flanged ends, bolted flanged yoke, outside screw rising stem and tapered solid wedge.

Fig. 3061—Class 300-pound Cast Steel Swing Check Valve with flanged ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through the valve body.

***The Complete Powell Line includes Globe, Angle, "Y", Gate, Check, Non-return, Relief, and Flush Bottom Tank Valves in Bronze, Iron, Steel and a wide range of Corrosion-resistant metals and alloys.**

Ask your nearest Distributor—or write direct

The WM. POWELL Co., 2525 Spring Grove Ave.
P. O. Box 106, Station B, Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

Just TWIST its neck

Install the American Every Angle Thermometer in any difficult place, on an irregularly shaped tank, boiler or other equipment.

Then turn its face to the exact spot where you can see it best. If the light changes turn it again —as many times as you want— for it will survive many thousand turns without impairing its enduring accuracy.

It is adaptable to all types and shapes of process equipment for the neck can be moved and turned to a full 180 degrees on two axes.

This useful feature does not affect the accuracy in any way for the fine quality of American Thermometers has kept them leaders for a hundred years.

1850—1950
A Century of Service to American Industry

American Glass, Dial and Recording Thermometers are sold by leading distributors everywhere. Write to them or us for information.

MAXWELL MANNING M&M MOORE INC. TRADE MARK

AMERICAN
Industrial Instruments

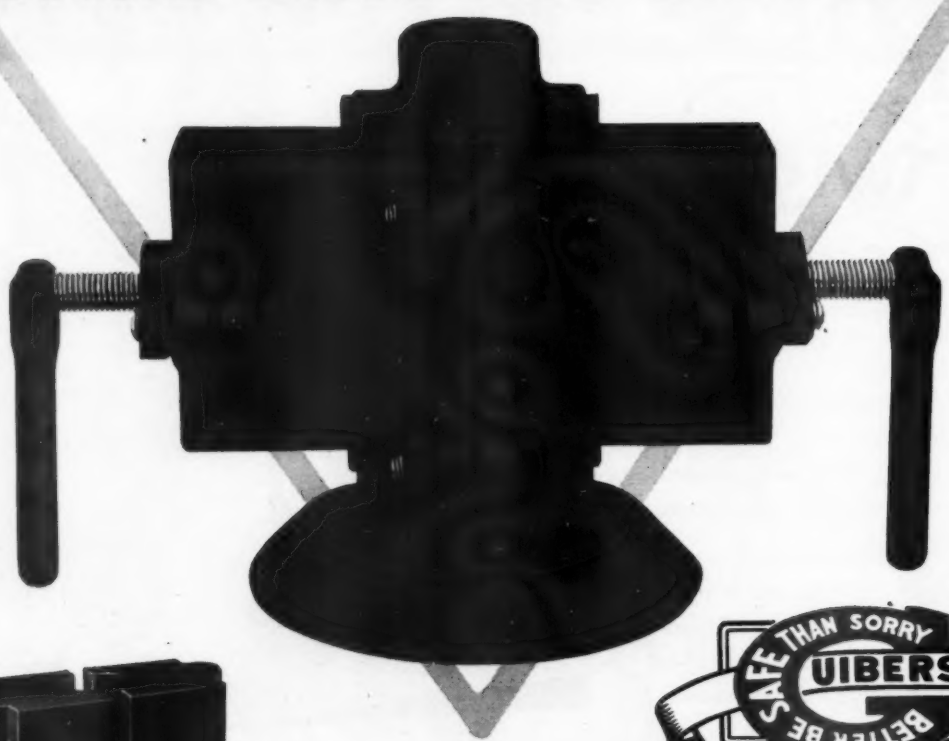
A Product of
MANNING, MAXWELL & MOORE, INC.
STRATFORD, CONNECTICUT

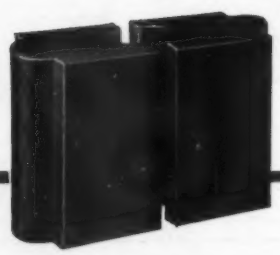
Makers of 'American' Industrial and 'Microsen' Electrical Instruments, 'Hancock' Valves, 'Ashcroft' Gauges, 'Consolidated' Safety and Relief Valves. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties.

XUM

NEW GUIBERSON TYPE "S"

WIRE LINE OIL SAVER





SPECIAL LONG WEARING RUBBERS

Resilient yet highly resistant to wear, these moderately priced Guiberson rubbers are simply inserted behind the old ones. Packed two pair to a box.

SAFE THAN SORRY — GUIBERSON — BETTER BE

SQUEE-GEE *ACTION!*

This low-cost, low upkeep, long-life oil saver cleans the wire line very efficiently. Equipped with extra-heavy duty brass bushings, both *above* and *below* rubber, New rubbers are inserted in minutes. Made for ½" thru 1" wire line sizes. Available with 5½" or 7" Berry Head flange.

SOLD BY LEADING OIL FIELD SUPPLY STORES EVERYWHERE

GUIBERSON

What Happens When 150,000,000 People Say:

"I WANT!"

THE STORY OF OIL

COLONEL Edwin Drake's oil well, drilled in 1859, produced only 20 barrels daily . . .

But it gave people a taste of the benefits of petroleum—and a great industry was off to a flying start!

The first drilling rigs—first refining equipment—were adequate for that early demand.

But invention of the automobile, airplane, Diesel engine and other great machines in turn demanded great invention in oil—and old-fashioned equipment gave way to scientific research laboratories, modern refineries, pipelines, tankers and tank cars.

Each year demand made them bigger and better!

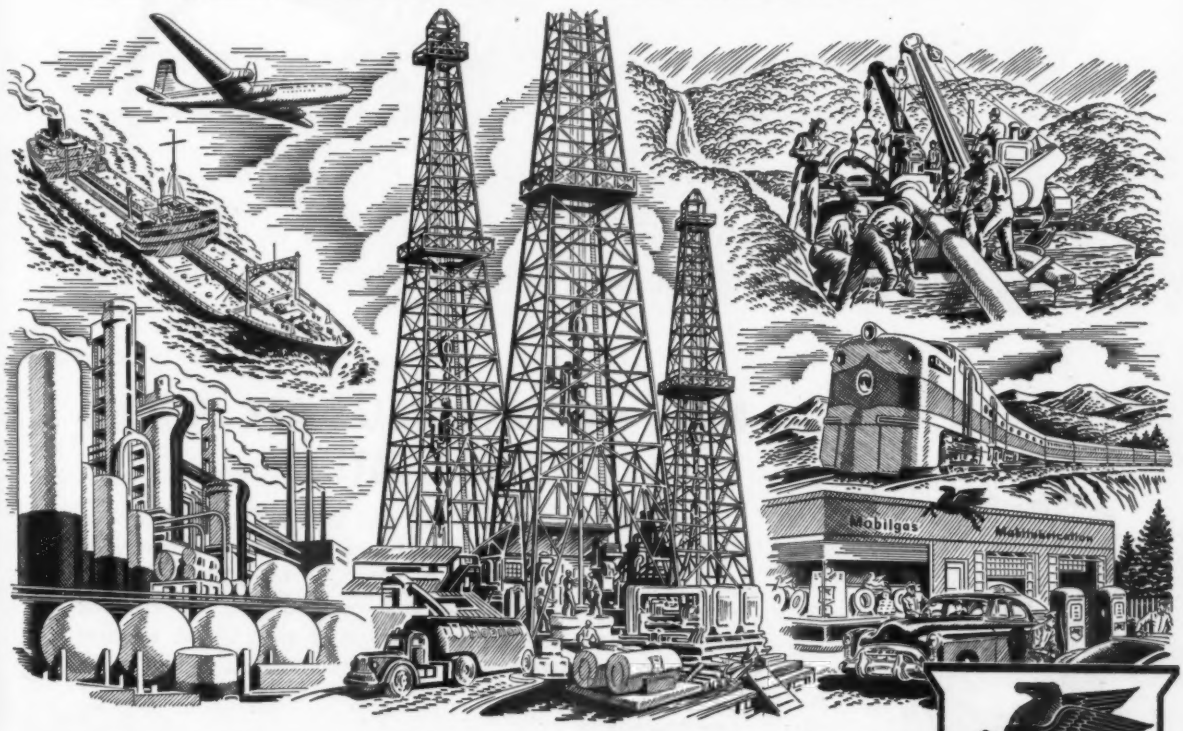
Today, thousands of oil companies with oil fields, refineries, bulk plants, service stations and cost-cutting transportation systems—deliver over 1,840,000,000 barrels of petroleum yearly—meet U.S.A.'s demands for *value in oil.*

And, today, the responsibilities of Socony-Vacuum, one of the oldest companies in the industry, are constantly mounting . . .

Unprecedented demand for petroleum products calls for expansion in every phase of our efficient, coordinated operation . . .

46,400 independent "small" businessmen must be kept *competitive*—supplied with what it takes to provide a *big money's worth* for you—a good living for themselves.

When 150,000,000 Americans say, *"I want,"* it takes businesses of all sizes to deliver!



DEMAND DETERMINES BIGNESS

The Flying Red Horse Companies

SOCONY-VACUUM OIL COMPANY, INC. • MAGNOLIA PETROLEUM CO. • GENERAL PETROLEUM CORP.

SOCONY-VACUUM

XUM

DOES YOUR POWER STACK UP WITH LCP* FOR *Flexibility?*

MORE and MORE WELLS ARE PUMPED BY *LCP EVERY DAY!

I'm a **FLEXIBLE** fellow! I can take on a full 24-hour shift or work according to any fractional time schedule! You pay only for the power required to get the job done! My **FLEXIBILITY** —plus automatic control, lower first cost, and lower upkeep stack up in my favor! The Power Engineer of your Utility Electric Power Company has proof of my performance—give him a call today!

*LOW COST POWER

PETROLEUM ELECTRIC POWER ASSOCIATION

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THI
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XUM

THE *RIGHT* CONNECTION FOR LONG, LOW-COST DRILLING SERVICE

The single pin connector link of the Baldwin-Rex "BA" Assembly, makes possible a new *high* in chain life . . . a new *low* in chain cost in Riveted Oil Field Roller Chain!

Now, with the "Baldwin-Assembly" you can get all the advantages of riveted roller chain . . . longer life, lower cost, greater strength. And, you get even easier assembly and disassembly than with old-style detachable roller chains.

You can see it for yourself. Note the washer spun over the head of the pin, the milled flat on the cottered end and the special hole in the connector plate. This combination holds the pin firmly in place, yet it is easy to remove because it is a "sliding" fit through the entire link except for the milled flat end.

You can easily remove this pin without destroying press fits or damaging chain parts.

And, an important additional advantage . . . the other end of the single pin connector link is firmly riveted to the adjacent link. When the single pin connector is removed, this riveted pin holds chain parts together, preventing plates from falling out, thus simplifying assembly.

Two single pin connector links are assembled with each five feet of "BA" chain. This assembly, plus standard 3-pitch repair units, makes it easy for you to make adjustments and repairs in the field.

For the complete story on the Baldwin-Rex "BA" Assembly, Rex A.P.I. Chains and Rex Oil Field Pumps, see your local supply store or write Chain Belt Company, 1619 W. Bruce Street, Milwaukee 4, Wis.

BALDWIN·REX

ROLLER CHAINS

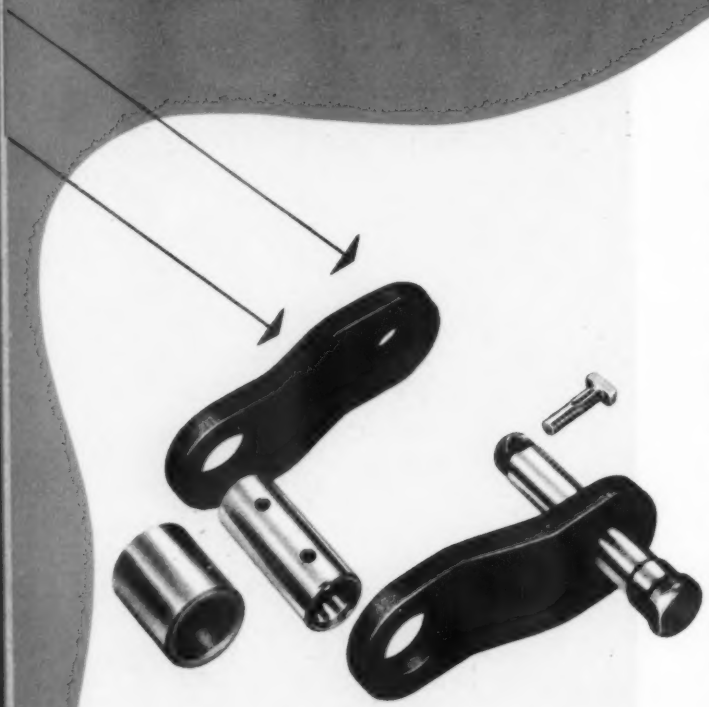
a complete line from ¼-inch to 2½-inch pitch

XUM

THESE PARTS STAY *PUT*

FOR DEPENDABLE DRILLING SERVICE . . .

Rex Champion No. 3. Other A.P.I. sizes, Rex Champion No. 4, Rex Deepwell No. 3 and No. 4, Rex Chabelco No. 3125.



Under the toughest of drilling conditions you can expect Rex A.P.I. Chains to stand up . . . to deliver dependable, low-cost service.

The reason is not easy to see but is easy to understand. Pins, rollers, bushings and side bars are made of high quality steel and are carefully heat-treated to develop maximum strength. Then, these precision-made parts are accurately machine-assembled to form the famous Rex Unit link. Each link is exactly alike . . . each is *put together to stay* . . . to retain its strength and uniformity under the most adverse operating conditions.

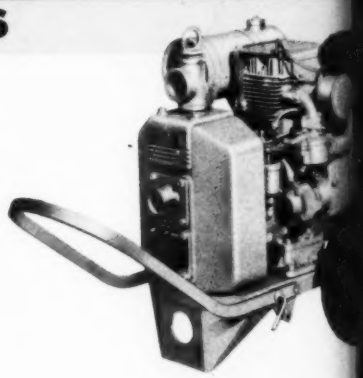
Rex A.P.I. Chains have many other advantages that are important to you. Side bar holes are machine-finished for accurate pitch and to assure full bearing between parts. There are no sharp corners to start cracking and quick loosening of the pin. The Rex Effective Lubrication System gets oil where it is needed for long life. The Rex Balanced Design balances the strength of chain parts for efficiency . . . longer life . . . lighter weight.

For A.P.I. chains that give you more, standardize on Rex!

CHAIN BELT REX COMPANY

OIL FIELD UTILITY PUMPS

THE ONLY PUMPS THAT GIVE YOU NEW PUMP EFFICIENCY FOR THE LIFE OF THE PUMP



Only Rex Oil Field Utility Pumps give you the adjustable "air peeler" and replaceable wearing plate that assure top efficiency and capacity *for life.*

When normal wear takes place, the peeler can be adjusted from the outside of the pump to compensate for the wear, thus restoring original efficiency. The wearing plate is easily and simply replaced when this step becomes necessary. The peeler also enables the pump to handle vapor bearing liquids without losing its prime.

Rugged construction, exceptional all-round portability, and light weight make these Rex Self-Priming Centrifugal Pumps preferred for oil field utility service. They are available in a wide range of sizes and capacities.

Rex Oil Field Sales Offices Are Located in the Following Cities:
NEW YORK • TULSA • DALLAS • HOUSTON • MIDLAND • LOS ANGELES

CHAIN BELT COMPANY

BALDWIN-DUCKWORTH DIVISION
Springfield 2, Mass.

REX CONSTRUCTION MACHINERY DIVISION
Milwaukee 4, Wis.

REX CHAIN & TRANSMISSION DIVISI
Milwaukee 4, Wis.

XUM

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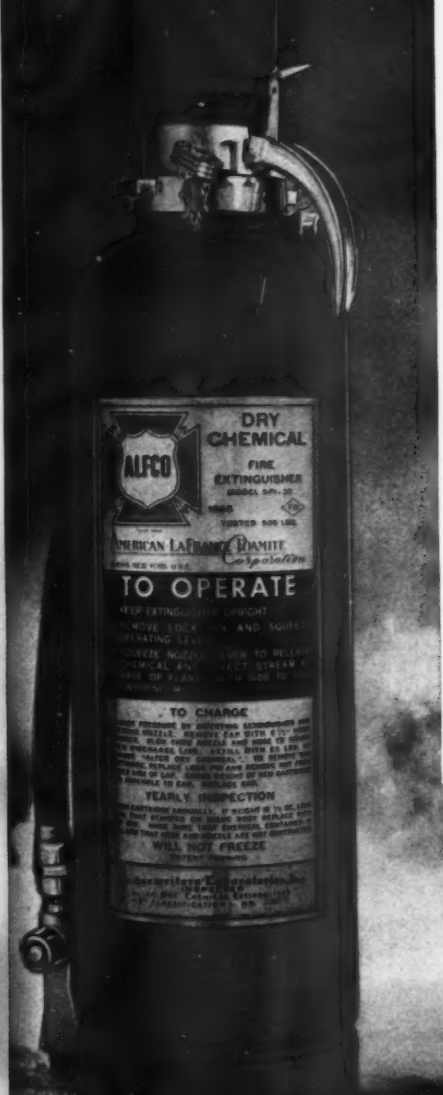
FIGHT FIRE THE NEW EFFECTIVE... *ALFCO* DRY CHEMICAL WAY!



The NEW ALFCO DRY CHEMICAL FIRE EXTINGUISHER

Longer range at all climatic temperatures! . . . Longer duration of discharge at all climatic temperatures! . . . More complete discharge of Dry Chemical contents! . . . May be operated in any carrying position! . . . Scientifically designed nozzle provides for wider coverage of fire area! . . . Gas-tight, all-internal expelling gas connections! . . . Built-in safety disc! . . . Hose couplings neatly swaged to hose for greater strength, smarter appearance! . . . High hose-mounting position avoids compacting of Dry Chemical—affords neater appearance! . . . Easy to recharge without special devices or replacement parts! . . . Occupies only 7" x 9" floor space! . . . Lighter weight—only 42 lbs. when ready for use! . . . Alfco Dry Chemical is nontoxic, noncorrosive, nonconductor of electricity and will not freeze! Underwriters' ratings: B-1, C-1. Recommended for flammable liquid and electrical fires.

Overall height 30"; Floor space occupied 7"x9"; Weight of Extinguisher, empty 17 lbs.; Weight of Dry Chemical Charge 25 lbs.; Weight of Gas Charge 8½ ozs.; Weight of Extinguisher charged for use 42½ lbs.; Total Weight packed for shipping 45 lbs.; Nozzle 6" long; Hose and Nozzle lengths approx. 26"; Shell Drawn Silicon Bronze; Finish Baked Bright Red Lacquer.

Write us for literature and for demonstration.

OUR *2nd Century of Leadership in* FIRE PROTECTION

AMERICAN-LAFRANCE-FOAMITE *Corporation*
ELMIRA · NEW YORK · U.S.A.

ALFCO
TRADE MARK

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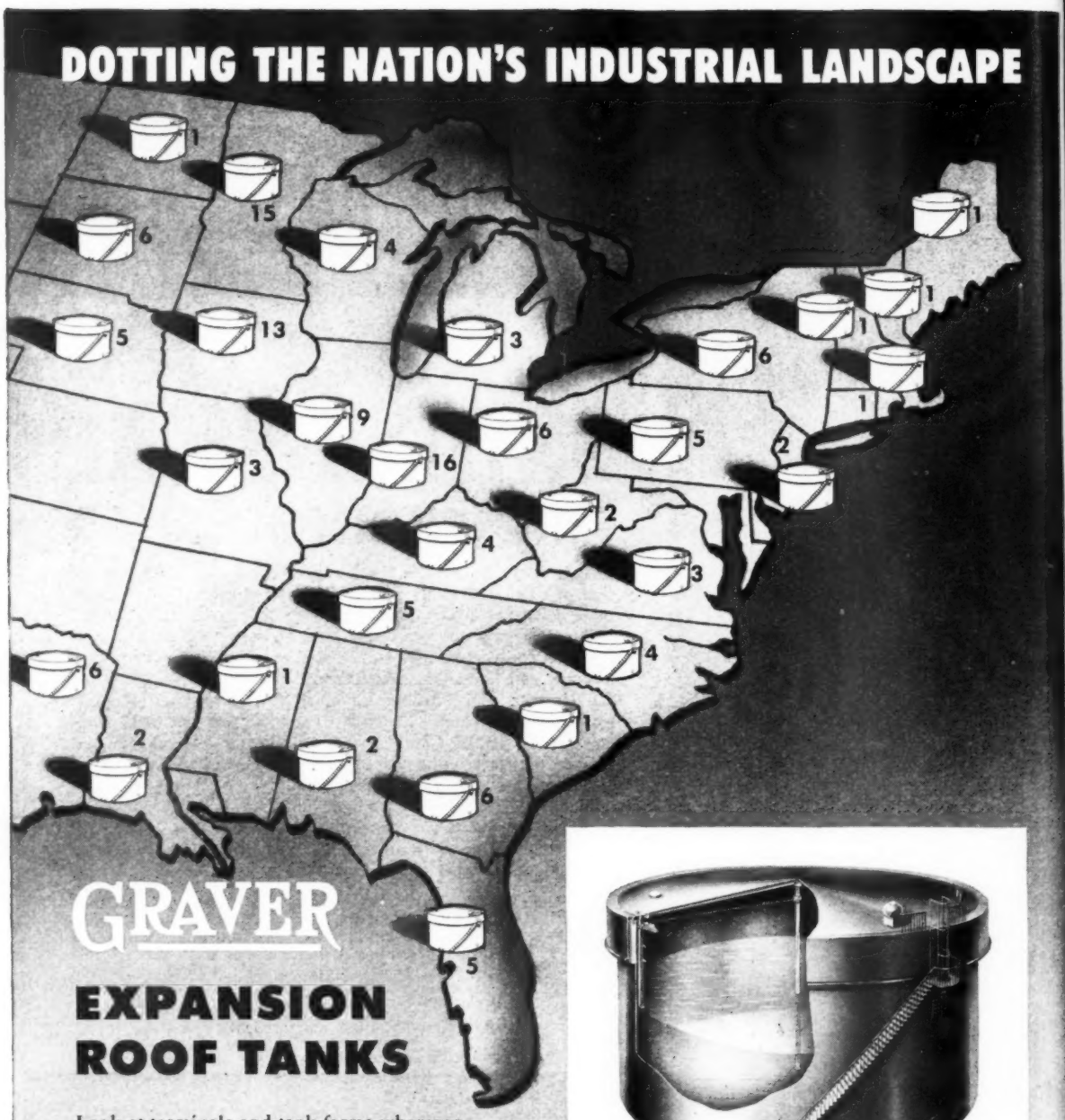
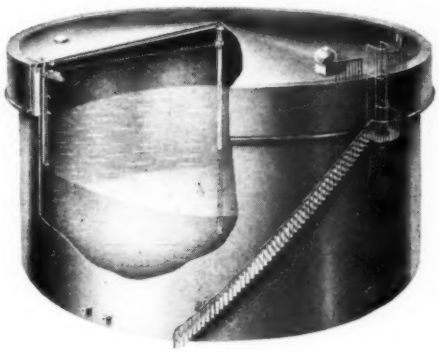
DOTTING THE NATION'S INDUSTRIAL LANDSCAPE



GRAVER

EXPANSION ROOF TANKS

Look at terminals and tank farms wherever you go and you will see Graver Expansion Roofs. As indicated by the figures on the map, there are Graver Expansion Roof Tanks keeping *Conservation At Work* in the majority of these United States. Industry acceptance of the Expansion Roof is clearly established with vapor savings and maintenance economies that have been matters of record for more than a decade.



Cut-away view of the Graver Expansion Roof Tank.

FABRICATED PLATE DIVISION

GRAVER TANK & MFG. CO., INC.

EAST CHICAGO, INDIANA

NEW YORK • PHILADELPHIA • CHICAGO • CATASAUQUA, PA. • HOUSTON • SAND SPRINGS, OKLA.

GRAVER

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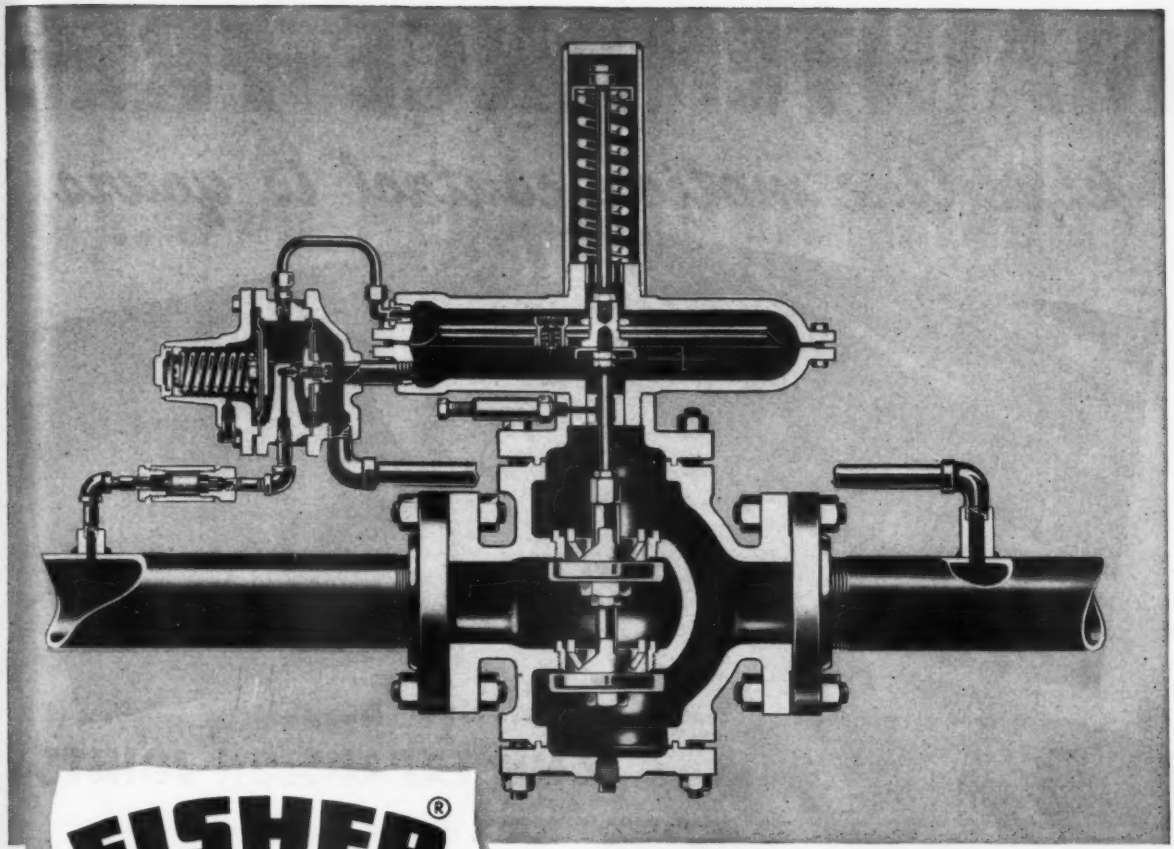

FISHER®
"299-61"
Ultra Sensitive
PRESSURE REDUCING GAS REGULATOR

The new Fisher Type 299-61 is solving hundreds of gas control problems. The pilot loading, pressure balanced principle of operation develops stable precision control over a wide range of pressure and flow.

For reduced pressure from 2 to 65 psi and for inlet pressure up to 150 lbs. Handles unusual capacity and load changes while maintaining extremely accurate control pressure. Available with hard or soft seat construction in pipe sizes 1" thru 12".

WRITE FOR BULLETIN P-299

FISHER LEADS THE INDUSTRY IN RESEARCH FOR BETTER GAS PRESSURE CONTROL

FISHER GOVERNOR CO.
MARSHALLTOWN, IOWA

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MAINTENANCE-FREE

pipe line motion control is yours

...with

CMH EXPANSION JOINTS

There's no longer any need to spend time and money on periodical maintenance of expansion joints. You can install CMH corrugated expansion joints and forget them . . . there's no packing to pull up or replace. In CMH expansion joints, the curvature of corrugations serves to minimize internal stresses and to provide balance of working stresses. This design coupled with advanced forming methods developed through years of research and experience assures long, trouble-free service. For a new installation or for replacement of obsolete equipment, specify CMH expansion joints for the practical, dependable answer to control of axial, lateral or radial motion in piping.

The illustrations show three typical installations of CMH Controlled-Flexing Expansion Joints.

A CMH TYPE to meet every need

CMH EXPANSION JOINTS are made as Free-Flexing for pressures up to 30 psi, Controlled-Flexing for pressures up to 300 psi and Flexoniflex for pressures up to 1500 psi, temperatures to 1600° F. Sizes range from ⅜" to 30" I. D. and larger. Available in copper, stainless steel or other alloys with flanged or welding ends.

Flexon identifies CMH products that have served industry for over 48 years.

CHICAGO METAL HOSE Corporation

1345 S. Third Avenue • Maywood, Illinois • Plants at Maywood, Elgin and Rock Falls, Ill.
In Canada: Canadian Metal Hose Co., Ltd., Brampton, Ont.

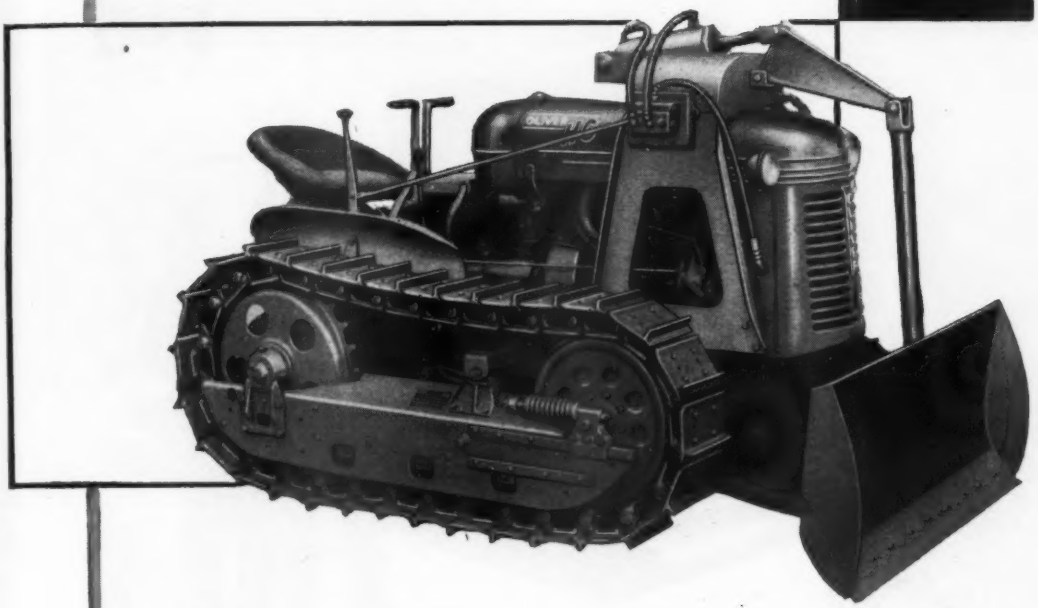
CMH

ONE DEPENDABLE SOURCE
for every flexible metal hose requirement

Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

More *strength . . .* **More** *power . . .* **More** *everything*

..in the NEW OLIVER "HG"



There's *more* of everything you want in a crawler tractor in the NEW Oliver Model "HG." This new little crawler tractor is "big" with performance-making features because it was *field designed* . . . designed to meet the specifications that users said they wanted.

The NEW OLIVER "HG" Has More Strength

To handle the extra load and strains of mounted equipment, the main frame, transmission case and drawbar bracket assembly have been materially strengthened. No loads are imposed on final drive spacer casting. Power take-off is heavier . . . stronger.

Front wheels have been increased 50% in material thickness for longer life. Wheel flanges are on the outside of the track rails for better track alignment. New, heavier type track frame guide supports and buffer springs add strength to handle mounted equipment.

Final drive has been redesigned for greater physical strength and durability.

The NEW OLIVER "HG" Has More Power

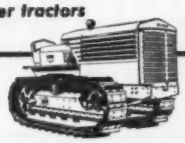
The new "HG" engine gives you more drawbar horsepower . . . extra power to handle bigger loads . . . extra efficiency.

Check the new Oliver "HG" at your Oliver Industrial Distributor's now. It's the biggest little tractor you've ever seen.

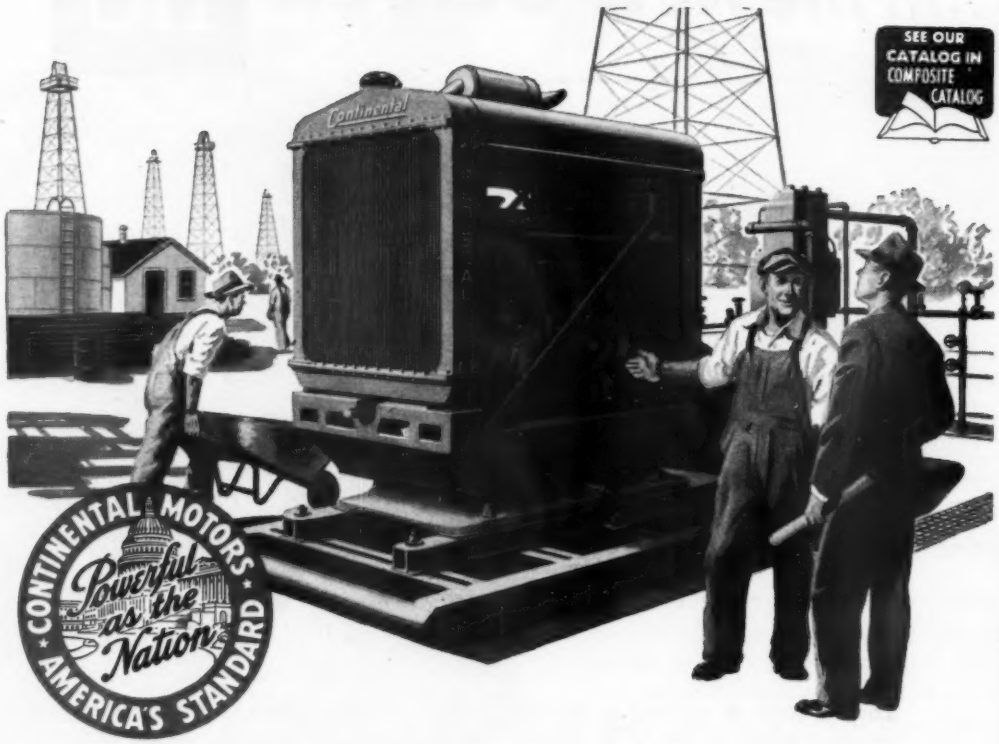
THE OLIVER CORPORATION

Industrial Division: 19300 Euclid Avenue, Cleveland 17, Ohio

A complete line of industrial wheel and crawler tractors



THE MORE RELIABILITY COUNTS...
THE MORE YOU NEED
RED SEAL POWER



When choosing power for oil field use, keep two things in mind:

1. ***The more closely the power plant is engineered to its job, the better its performance and the lower your operating costs.***
2. ***Whatever the specific need, there's a Continental Red Seal engineered and built to meet it—not approximately, but "right on the nose."***

Continental builds prime movers matched to the needs of most drill rigs, and models for workover rigs, transfer pumps, mud pumps, winches and auxiliary drilling equipment, as well as for standby use with generators, pumps and processing equipment. Since it manufactures to more than 1,000 different specifications, there are one or more built-for-the-job models for virtually every oil field application within the broad power range spanned by the Continental line.

GENUINE CONTINENTAL PARTS AND FACTORY-AUTHORIZED SERVICE FROM COAST-TO-COAST

Continental Motors Corporation

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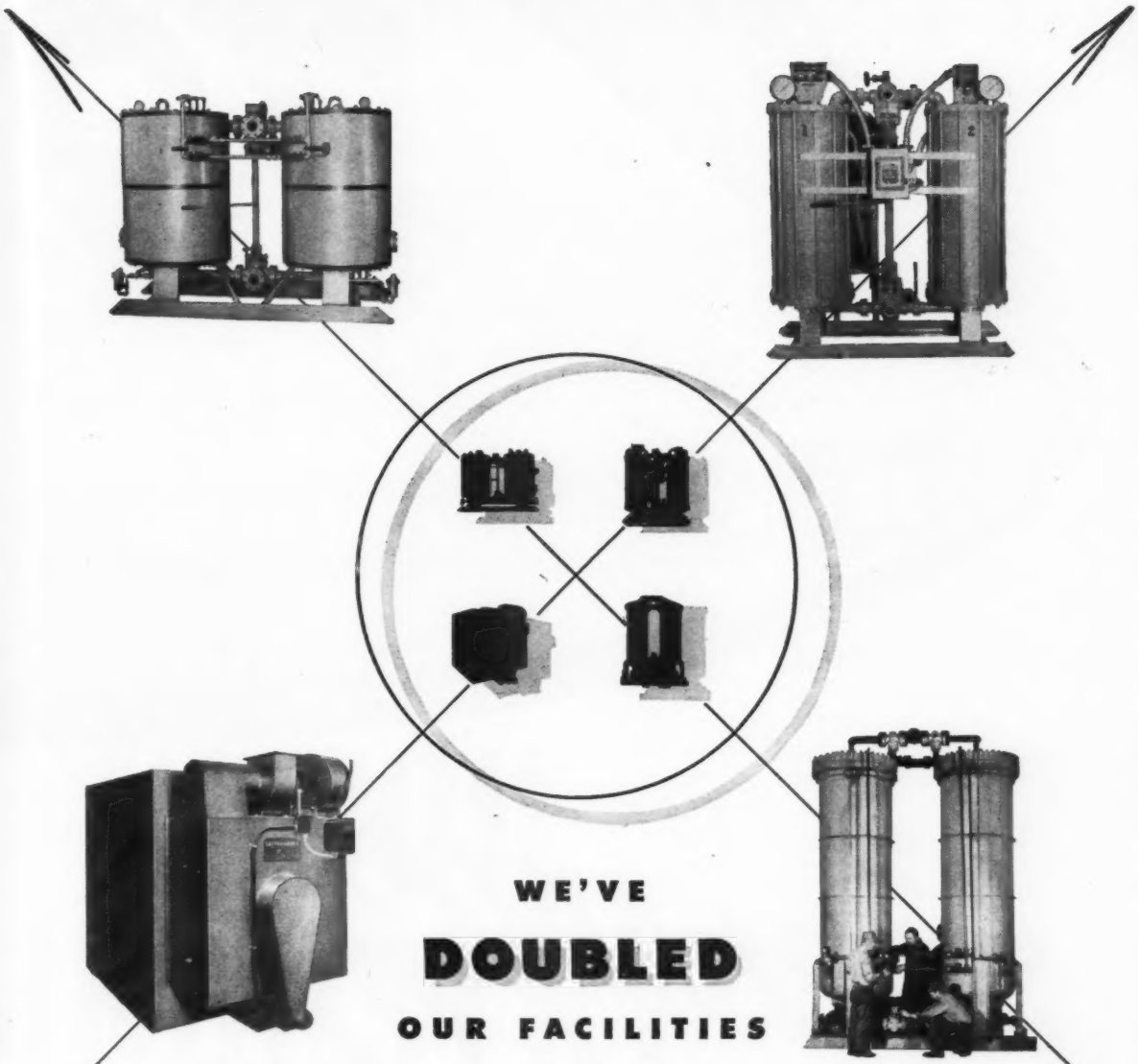


WE'VE DOUBLED OUR FACILITIES

LECTRODRYERS for DRYing air, gases and organic liquids, a few cubic feet per hour or tons a minute, hand-operated or fully automatic, at atmospheric pressure or 5,000 psi. DRYing continues to be our specialty in these greatly expanded quarters.

DRYing feeds and end products to uniformly low dewpoints is now a widely accepted practice in the Petro-Chemical Industry. Processes are kept on the beam and product quality is higher. Lectrodryers do that DRYing—efficiently and at low cost.

Standard Lectrodryers handle many of these DRYing operations without change. Where requirements are unusual, however, slight modifications of these standard machines often suffice. Thus you avoid unnecessary engineering development work and loss of time required to build special equipment.

Lectrodryer engineers have the know-how needed to solve your DRYing problems. For this help, write Pittsburgh Lectrodryer Corporation, 325 32d Street, Pittsburgh 30, Pennsylvania.

In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Glebe, Sydney.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

REGISTERED TRADEMARK U.S. PAT. OFF.

Serving

IN grateful acknowledgment of the extent to which you oil men depend on Jones & Laughlin Supply service, our policies include these "musts":

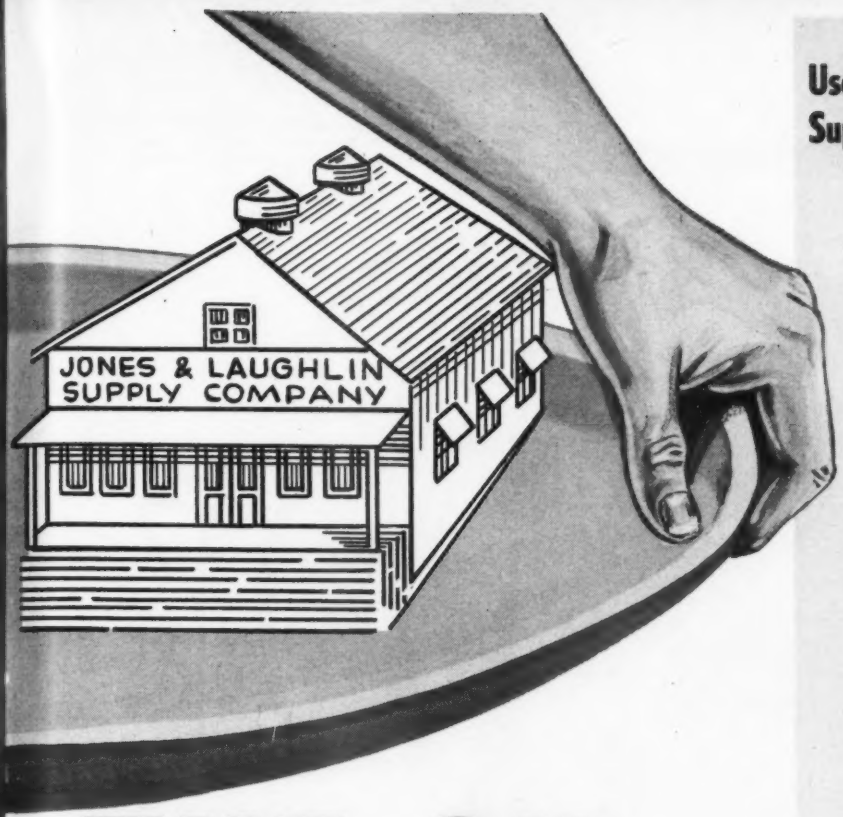
First—to establish a "supply store" for you wherever you find oil in commercial quantities. We try to move in right behind the wildcatters and to maintain continuous operation of each store as long as there is a need for it in the area served.

Second—to stock this warehouse with the best the market affords. Keep this stock up-to-date as reflected by the requirements of local activities.

Third—to maintain prices and terms on a fair and reasonable basis.

Having followed this practice for many years, there is hardly a highway or byway in the oil country between the Rockies and the Atlantic and from Canada to the Gulf that isn't served by one of our 79 stores. Check the list on the right hand page for the store nearest you.

Our people will make you welcome, will serve you well, and will save you time and money. These supply points of service are a vertebra in the backbone of the petroleum industry.



THE OIL INDUSTRY

Jones & Laughlin Supply Company

. . . here's MY warehouse!"

Subsidiary of Jones & Laughlin Steel Corporation

J&L STEEL

TULSA, OKLAHOMA

Export: 405 Lexington Ave., New York, N. Y., U.S.A.

Use the Jones & Laughlin Supply Point Nearest You

ARKANSAS
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Craig — Rangely (Pump Shop Only)
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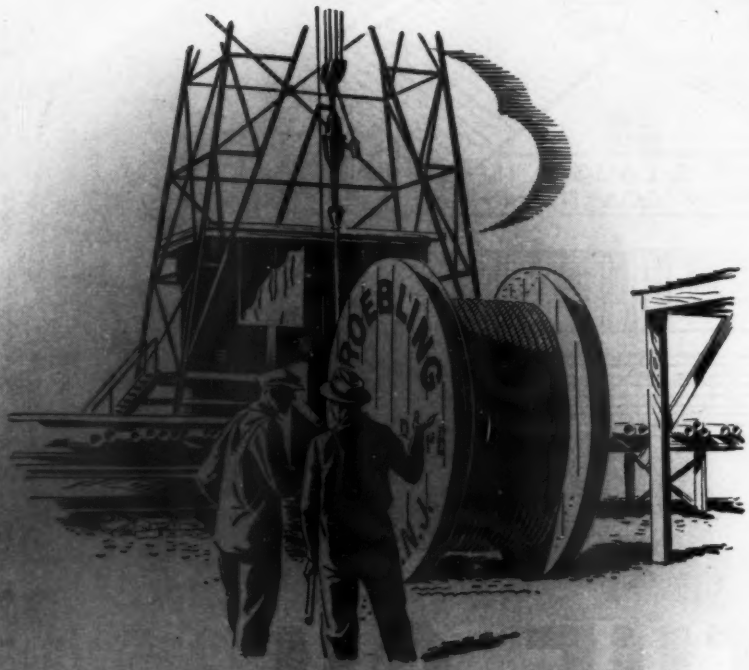
XUM

As rotary drilling lines, Roebling 6x19 Preformed "Blue Center" Steel Wire Rope with Independent Wire Rope Core has demonstrated extra life on the job and substantial dollar savings.



For rope research and developments that help you save...

Today it's Roebling!

JOHN A. ROEBLING'S SONS COMPANY, TRENTON 2, NEW JERSEY

YEAR BY YEAR, industry makes new and more stringent demands upon wire rope . . . and Roebling leads in developing types that meet these demands with utmost efficiency and economy.

Take Roebling Preformed "Blue Center" Wire Rope with Independent Wire Rope Core!

No finer rope has ever been made, and its basis is "Blue Center" steel—an exclusive Roebling development. Its high resistance to abrasion, shock and fatigue spells long life . . . To this, Roebling *Preforming* brings the further advantages of new handling ease and improved performance . . . And the addition of I.W.R.C. assures top resistance to operating pressures and provides increased rope strength.

Roebling makes a wire rope of the right construction, grade and size for every type and make of rope-rigged equipment. Have your Roebling Field Man recommend the best rope for low-cost performance on each of your installations.

ROEBLING

A CENTURY OF CONFIDENCE

DISTRIBUTED BY
THE NATIONAL SUPPLY COMPANY
REPUBLIC SUPPLY COMPANY

Submersible Drill Barges-

"A COMPLETE PACKAGE"

BY

Levingston

From crown block to barge bottom, Levingston is prepared to accept the entire responsibility of constructing and rigging-up your submersible drill barges on a turn-key basis. You select the tools, or equipment, and Levingston's experienced organization will install them for safe and efficient operation on marine locations.

LEVINGSTON BUILDS FINE SPECIALIZED MARINE EQUIPMENT FOR THE PETROLEUM INDUSTRY

Non-self propelled oil well drilling tenders—converted LST's

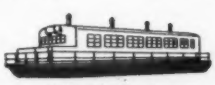
Drilling barges converted from navy seagoing barges.

Self-propelled oil well drilling tenders—converted LST's

Submersible drill barges

Vessels for geophysical exploration

Crew boats



Boiler and power barges

Compressor barges

Water, oil and supply barges

Levingston

SHIPBUILDING COMPANY • ORANGE, TEXAS

Tugs

stay "on stream" longer with K-68

the oil-resistant gasket material

K-68 is winning new friends daily in refineries, cracking plants, gas plants, and wherever heat, oil, and distortion are problems. It's a tough oil-resistant sheet that retains resilience.

K-68 is a compressed asbestos sheet made of highest quality, long-fibre asbestos, bonded with Neoprene. It has a positive, but very low, percentage of swelling against oils and fuels. It meets specification AMS-3232. It's on the approved list of specification AN-G-171.

K-68 contains no sulphur and is therefore especially recommended for refrigeration equipment and chemical installations where this property is required.

K-68 is just one of the many gasket materials and packings made by Raybestos-Manhattan for the oil and gas industries. For complete information on this and other R/M packings, see your local supply store or send us the coupon below.

RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, MANHEIM, PA.

FACTORIES: Bridgeport, Conn. • Manheim, Pa. • No. Charleston, S.C. • Passaic, N.J.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Packings • Asbestos Textiles • Mechanical Rubber Products • Abrasive and Diamond Wheels Rubber Covered Equipment • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Powdered Metal Products • Bowling Balls

RAYBESTOS-MANHATTAN, INC. O-70
Packing Division, Manheim, Pa.
Gentlemen: Please send me data on K-68.

Name _____
Position _____
Company _____
Address _____
City _____ Zone ____ State _____

RM

XUM

ACCURACY

not for its own sake but because it

Reduces your Piping Costs

Exceptional dimensional accuracy and uniformity of Midwest Welding Fittings speeds piping work and reduces cost. All pipe can be cut in advance according to drawings, with assurance of accurate fit. Welders do not have to spend costly time struggling to line up fittings and pipe. Welding proceeds rapidly, economically with no time-wasting compensation for inaccuracies.

All critical dimensions of Midwest Fittings are accurate and uniform. For example, Midwest Welding Elbows are first made slightly oversize. They are then reheated to forging temperature and brought to final size in compression dies. In addition to relieving stresses from forming and welding, this assures true circular cross-section, controlled wall thickness and accurate radius, included arc and tangents. Midwest Elbows and Tees have accurate welding bevels, included angles, etc., because all ends are machined simultaneously in special machines.

There is a Midwest Distributor near you. Get in touch with him for your fitting needs. Also ask for Catalog 48.

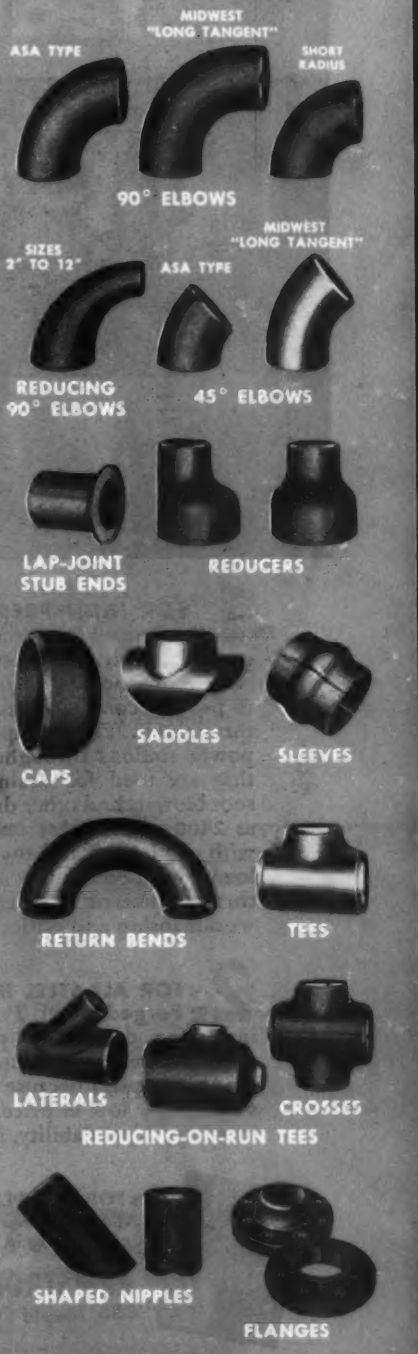
4098

MIDWEST

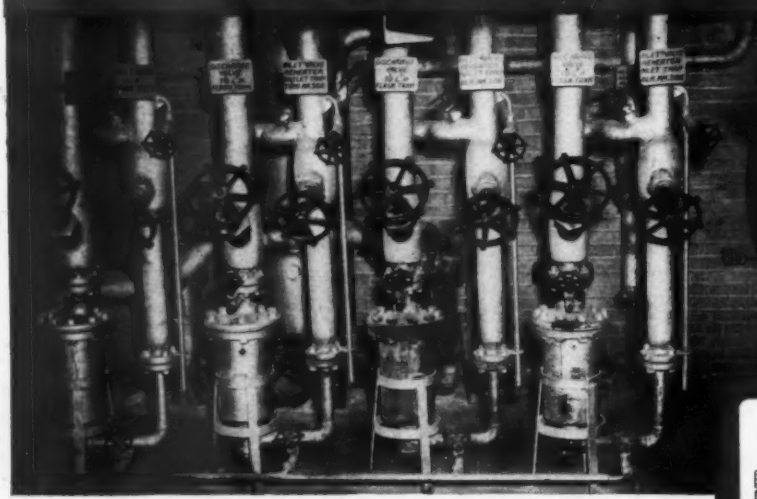
PIPING & SUPPLY COMPANY, Inc.

MAIN OFFICES: 1450 SO. SECOND STREET, ST. LOUIS 4, MO.
Sales Offices: New York 7—30 Church St. • Chicago 3—79 W. Monroe St.
Los Angeles 33—520 Anderson St. • Houston 2—1213 Capitol Ave.
Tulsa 3—533 Mayo Bldg. • South Boston 27—426 First St.
Stocking Distributors in All Principal Cities

MIDWEST WELDING FITTINGS Improve Piping Designs and Reduce Costs



FORGED STEEL steam traps



List of Materials

CAP and BODY FORGINGS:*
Up to 600 psig—S.A.E. 1030 steel
600 to 900 psig—ASTM F-1 moly-steel
900 to 1500 psig—ASTM F-7 chrome moly-steel

VALVE AND SEAT:
Chrome steel, heat treated

BUCKET and VALVE LEVER ASSEMBLY:
18-8 Stainless Steel

BOLT and NUT SET:*
Bolts Class C, 125,000 lbs. tensile
Nuts, hex, semi-finish, S.A.E. 1030

GASKET:*
Compressed graphited asbestos

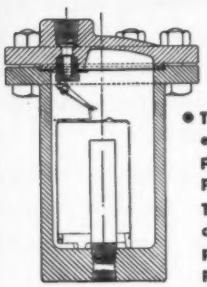
*Does not apply to No. 3211 nor No. 913

1. **FOR HIGH PRESSURE SERVICE** — engineers responsible for the design or operation of high pressure, high temperature steam plants can specify with confidence Armstrong Forged Steel Steam Traps to provide completely automatic condensate drainage throughout. These traps are "standard" in leading power stations throughout the entire world where they are used for draining headers, desuperheaters, soot blowers and other drip points at pressures as high as 2400 psig! These traps always open when filled with condensate and there is no steam loss under no-load conditions. Safety and dependability are assured through use of modern materials, highest quality workmanship and critical inspection.

2. **FOR ALL-STEEL INSTALLATIONS** — Armstrong Forged Steel Traps also ideally meet the increasing demand in power plants, refineries and general industry for all-steel fittings on lower pressures (up to 250 psig) because they are light in weight and surprisingly low in price. They provide the maximum in safety, dependability, shock and fire resistance.

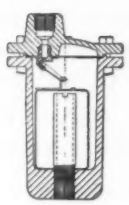
● FOR COMPLETE DATA ask for the 36-PAGE ARMSTRONG STEAM TRAP BOOK or see our catalog in Sweet's.

ARMSTRONG MACHINE WORKS
868 Maple Street, Three Rivers, Michigan

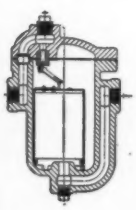


● Traps with screwed connections for pressures to 900 psig.

Traps with flanged connections for pressures to 2400 psig.



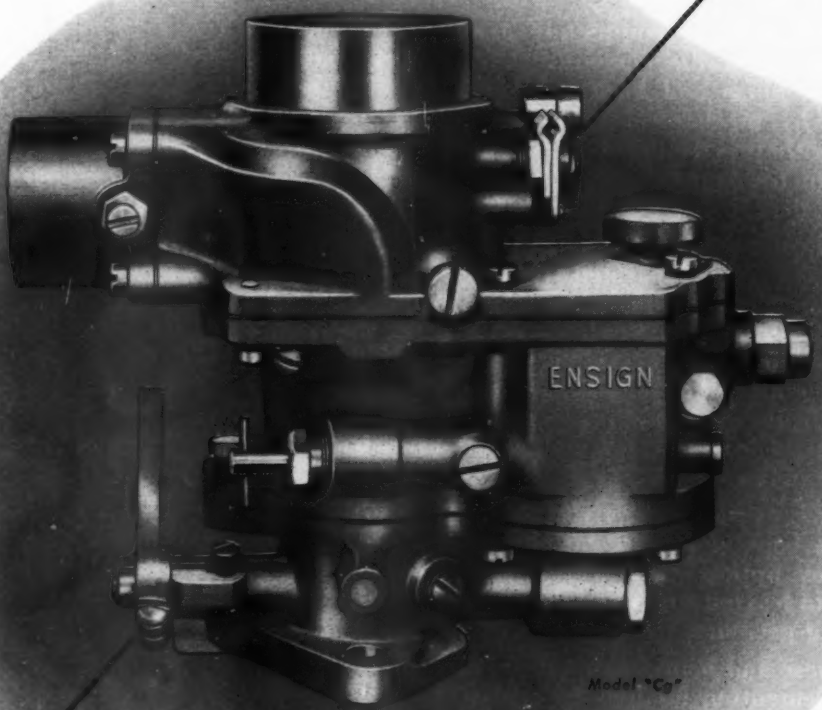
● No. 3211 trap for pressures to 250 psig, only $14.00.



● Side inlet cast steel trap for pressures to 600 psig, screwed or flanged connections.

ARMSTRONG STEAM TRAPS

ENSIGN*



Model "Cg"

Engines equipped with the Ensign Model "Cg" Combination Carburetor may be operated on either Natural Gas, Gasoline or Butane-Propane. Switching from one fuel to another is easily done with the engine running. Engine builders and users of gas-engine powered equipment specify the combination carburetor when there is some question about the availability of fuel on the job.

ENSIGN
CARBURETOR COMPANY
7010 S. ALAMEDA ST., P. O. BOX 229
HUNTINGTON PARK, CALIFORNIA
Branch Factory: 2330 W. 58th St., Chicago 36, Illinois

"Pioneers in Efficient Carburetion" since 1911

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YOU'RE SURE OF A MASTER JOB *Every Time*

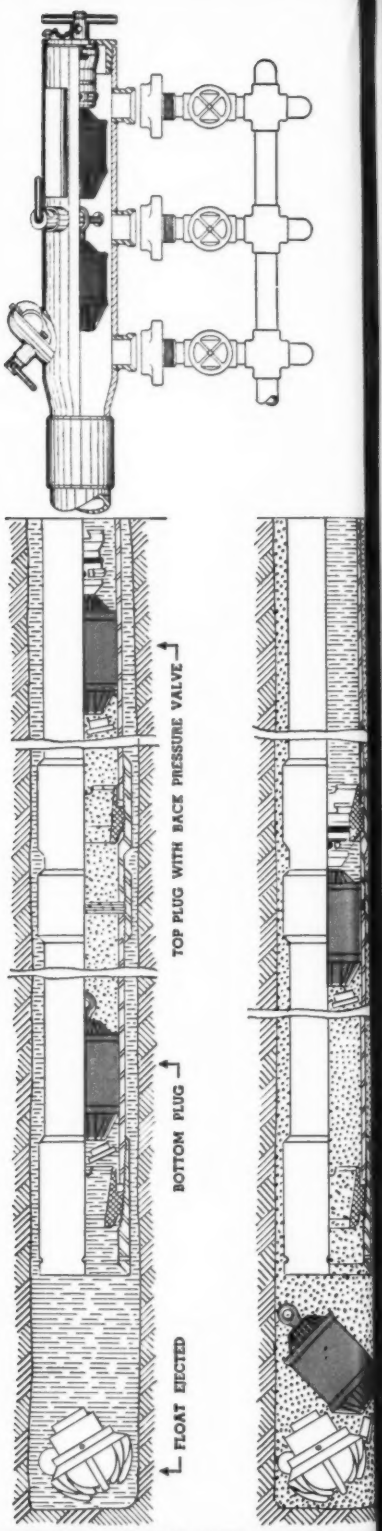
AND HERE'S WHY!

★ The head is completely assembled before making-up on the cementing string. Trip ball, the two plugs and back pressure valve are released by mechanical means from outside the head with practically no downtime. Air entrainment in the cement string is prevented by this closed circuit.

★ Uncontaminated cement is delivered at the casing shoe. It is separated from the drilling mud by the two plugs, which exert a swab like action on the casing, wiping it clean ahead of the cement column and cleaning casing of cement behind the cement column. Full casing bore discharge through the float shoe provides greater discharge capacity at lower pressure . . . minimizes hazard of channelling.

★ Back pressure valve eliminates possibility of cement backing up in casing string. Gives the operator option of bleeding pressure back to zero and leaving well open or closing it in at final running pressure.

★ These and many more advantages of the Fulbore Cementing Method make it the master of efficient, effective cementing. Ask your nearest Rector Representative, supply man or BLACKIE CLARK WELL SERVICE COMPANY for full details, or write for bulletin.



RECTOR WELL EQUIPMENT CO., INC.
FORT WORTH, TEXAS

Fort Worth Plant . . . . . 1100 N. Commerce St.
Houston Plant . . . . . 2215 Commerce St.

Representatives in All Active Fields

RECTOR FULBORE CEMENTING METHOD

ASK YOUR SUPPLY STORE FOR RECTOR "FULBORE" CEMENTING EQUIPMENT

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INFILCO FLOOD WATER CONDITIONING PLANT AT DELAWARE CONSOLIDATED OIL CO., DELAWARE, OKLA.

ONLY Properly Conditioned FLOOD WATER IS GOOD ENOUGH FOR YOUR WELLS

DON'T take chances on the flooding water you use! Untreated or improperly treated water can clog the formation by (1) suspended solids, (2) chemical reaction products, (3) organic growths on the face of the formation. When considering a secondary recovery project, it's just good business to *make sure that the water you use is absolutely safe!* Just write us, or call in our nearest field engineer. Get complete information about our *free laboratory service* . . a scientific analysis of *your* water supply and a prompt report.

Whether the available water is from a lime formation, a nearby lake or stream, exclusive *and proved* INFILCO methods and equipment will assure you a crystal clear, chemically stable water, practically free of hydrogen sulphide, when present, ideally suited for flooding purposes. Infilco installations from coast-to-coast are now conditioning over ONE BILLION GALLONS of water *every day!*

INFILCO

• BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894 •

INFILCO INC.

GENERAL OFFICES: 325 WEST ADAMS PLACE, CHICAGO 14, ILLINOIS

SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

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Ready to work on arrival

Uncrate it, lubricate it, and the "Ideal" Swivel is ready to go to work . . . whether your drill string is down 500 or 5,000 feet. No time-wasting run-in or break-in period . . . no need to pamper a new "Ideal" Swivel.

"Ideal" main bearings . . . vital point in the swivel . . . are lapped-in under load . . . later the assembled swivel is run-in under simulated field load before shipment. When you rig up your "Ideal" Swivel, it's ready to go, ready to handle its full load rating.

These precautions . . . plus tailor-made "Ideal" Electric Steel and field-proved design . . . assure you maximum, dependable service from an "Ideal" Swivel. Available in sizes for shallow, medium, deep, or deepest drilling. May we send you descriptive bulletins?

THE NATIONAL SUPPLY COMPANY

GENERAL SALES OFFICES: TOLEDO, OHIO

NATIONAL BLUE PRODUCTS

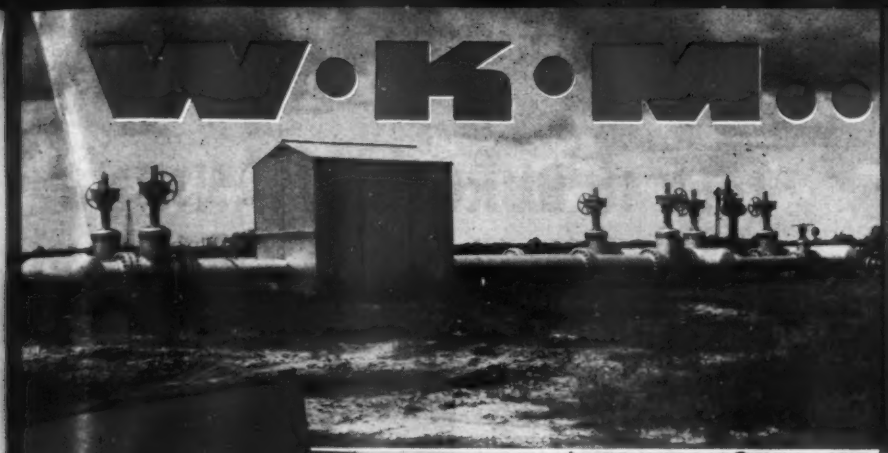
DIVISION OFFICES: CASPER; FT. WORTH; PITTSBURGH; TULSA; TORRANCE.

CANADA: THE NATIONAL SUPPLY COMPANY, LIMITED, ROOM 202, ALBERTA BLOCK, CALGARY, ALBERTA.

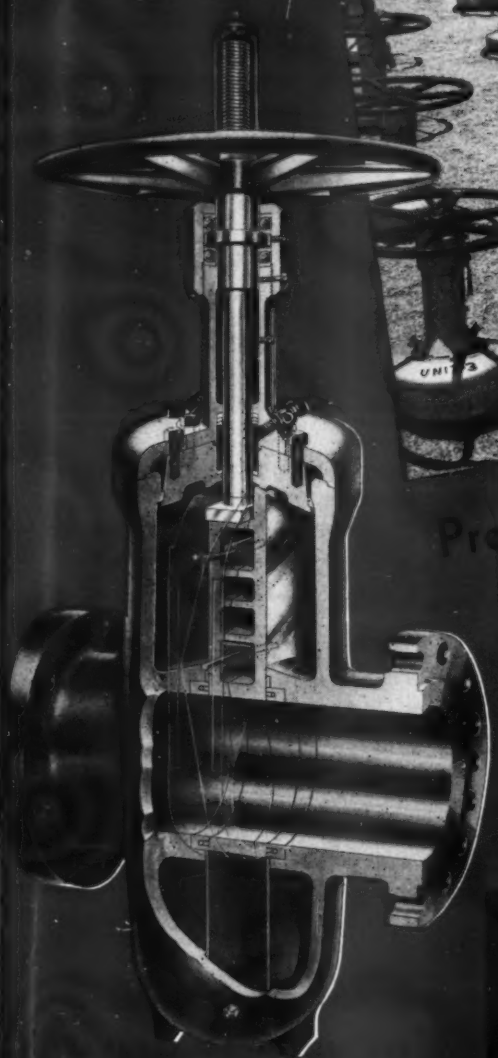
EXPORT: NATIONAL SUPPLY EXPORT CORPORATION, 30 ROCKEFELLER PLAZA, NEW YORK, N. Y., U. S. A. RIVER PLATE HOUSE, 12 SOUTH PLACE, LONDON E. C. 2.

NATIONAL OIL FIELD MACHINERY AND EQUIPMENT . . . SPANG PIPE . . . SUPERIOR ENGINES

W·K·M... • all the way!



W-K-M PIPE LINE VALVE



Preferred because it's DEPENDABLE

Sights like these above . . . pipe lines and stations equipped 100% with W-K-M Pipe Line Valves . . . are becoming more common every day as operators discover the many features of safety, dependability and economy provided by exclusive W-K-M design.

Full opening, with chrome-plated, parallel expanding gates that seal on *both* sides, W-K-M Pipe Line Valves seal positively against oil, gas or finished products; open and close easily; provide absolute top protection under all conditions. Available in Series 300, 400, 600, 900 and 1500, sizes from 2" through 30" in regular or geared models.

Check the many features of W-K-M Pipe Line Valves, compare them with other valves designed for similar services . . . and we believe that you too will specify W-K-M "all the way".

W-K-M Company

OIL FIELD, PIPE LINE & INDUSTRIAL EQUIPMENT

HOUSTON, TEXAS, U.S.A.

LOS ANGELES

Cable Address: WILKOMAC

Export Office: 30 Rockefeller Plaza, New York, N. Y.

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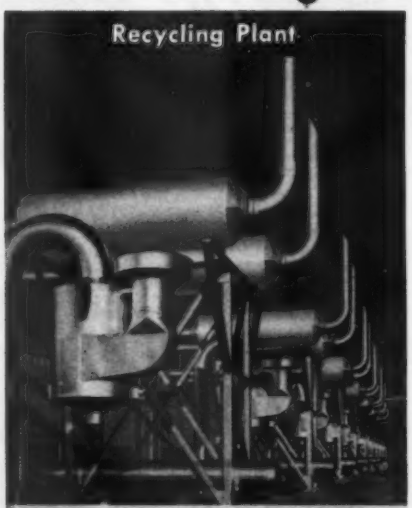
In the Petroleum Industry

Look to BURGESS-MANNING
Leader in Engine and Compressor Noise Reduction



Burgess-Manning Snubbers used on Clark engines at the Cotton Valley Recycling Plant.

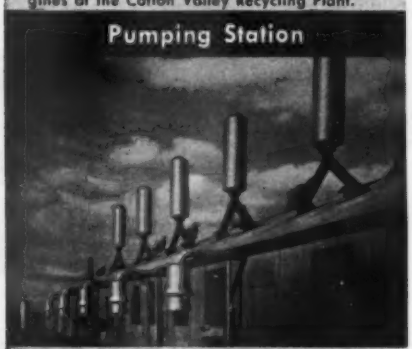
Burgess-Manning Snubbers used in a pipe line station.

Almost twenty-five years' experience in the design and application of Snubbers has given Burgess-Manning the know-how to help solve your engine and compressor noise reduction problems.

Burgess-Manning Snubbers smooth the flow of exhaust gas or intake air without restricting gas flow. Exhaust or intake pulses of gas are effectively snubbed so that the oscillating flow of gas is smoothed to a unidirectional flow.

If you are installing engines or compressors, let Burgess-Manning submit Snubber recommendations. Long experience guarantees complete satisfaction.

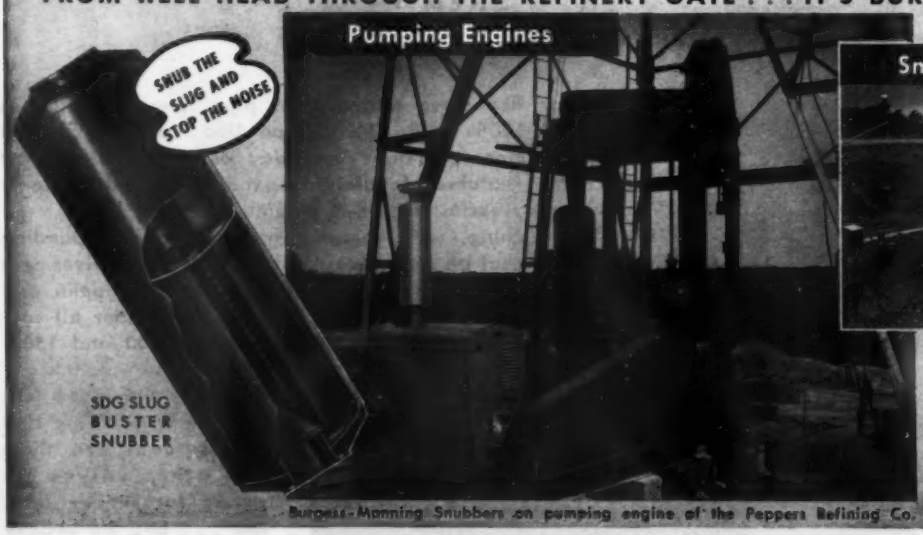
BURGESS-MANNING COMPANY
LIBERTYVILLE, ILLINOIS
749-G East Park Ave.



Burgess-Manning Snubbers on 180-hp gas engines used by a Kansas plant.

Burgess-Manning Snubbers used on engines of a pressure maintenance plant.

FROM WELL HEAD THROUGH THE REFINERY GATE . . . IT'S BURGESS-MANNING



Burgess-Manning Snubbers on pumping engine of the Peppers Refining Co.

Burgess-Manning Snubber installed on pipe line engine of the Magnolia Pipe Line Company.

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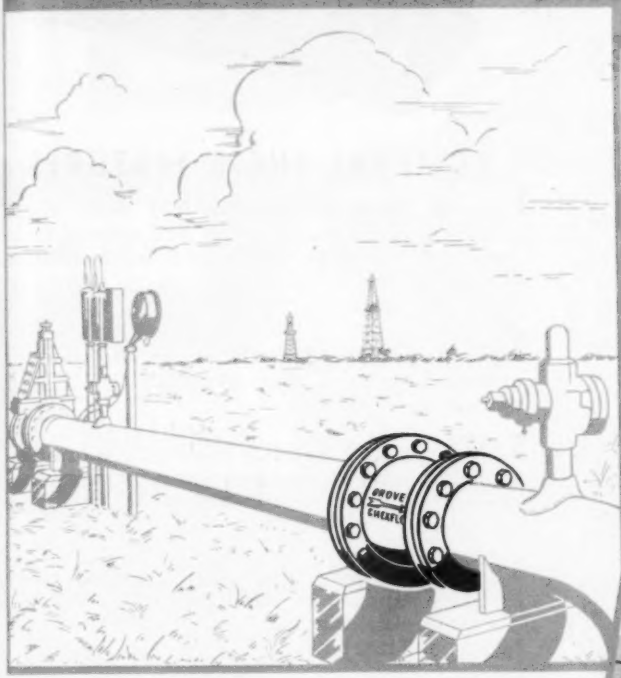
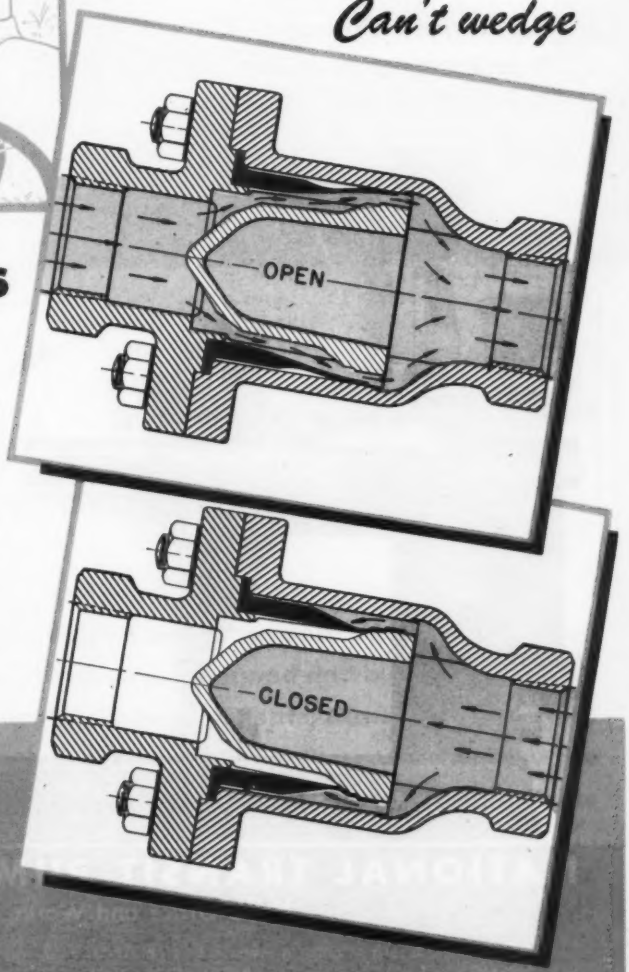
GROVE ChexFlo CHECK VALVES



ON METER RUNS

positive operation
leak-proof seal
no moving metal parts
full-flow capacity
minimum pressure drop

Can't stick
Can't slam
Can't wedge



ChexFlo NEVER FAILS TO OPEN OR CLOSE

The only moving part in the Grove ChexFlo Valve is a tough Buna N tube which fits tightly around a stationary metal core. In operation, only a fraction of a pound pressure is required to stretch the thin lip of the tube off the core, opening the valve with minimum pressure drop. The flow, streaming past the core, holds the rubber tube in the open position. When flow stops, the tube constricts shut around the core, closing tightly before the start of return flow. Reverse flow squeezes the tube more tightly on the core, making a seal which becomes tighter with increasing pressure. Specify Grove ChexFlo on your Meter Runs. Write for full information on the check valve that never fails to open or close. ***Grove "T" Valves on Meter Manifolds complete this efficient installation.***

GROVE REGULATOR COMPANY

3608 NAVIGATION BLVD., HOUSTON, TEXAS
6529 HOLLIS ST., OAKLAND, CALIF.
1930 W. OLYMPIC BLVD., LOS ANGELES, CALIF.

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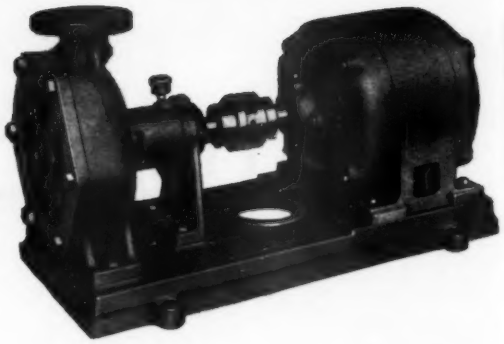
Transit Type CS Pumps

FOR CHEMICAL, PROCESSING AND GENERAL SERVICES



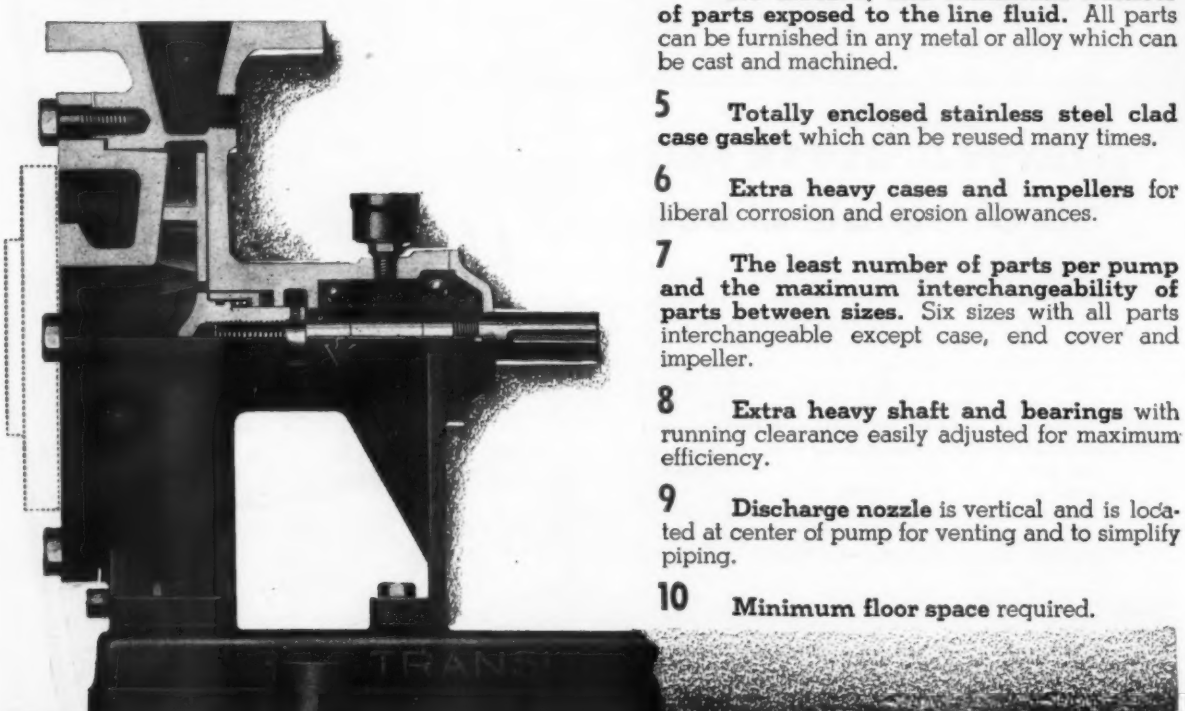
Max. working pressure 200 ppsi, 200 °F., 150 lb. Flange Drilling.

Capacities up to 550 G P M, differential heads to 160'.

Designed to give maximum strength, dependability, efficiency, and simplicity at minimum cost.

Ask for Bulletin 6100.

For Higher Pressures, Capacities and Temperatures, ask for Bulletin 6000, Transit Type ES.



COMPARE THESE FEATURES

1 **A balanced mechanical seal** which can be repaired from impeller end without making any precision measurement and without disturbing the shaft, bearings, coupling, driver, or discharge piping.

2 **Supported directly under the case** for maximum strength and freedom from piping strains.

3 **Case and bearing bracket are one integral casting** of the same metal for maximum strength, true alignment and 100% corrosion protection.

4 **No threads, and minimum number of parts exposed to the line fluid.** All parts can be furnished in any metal or alloy which can be cast and machined.

5 **Totally enclosed stainless steel clad case gasket** which can be reused many times.

6 **Extra heavy cases and impellers** for liberal corrosion and erosion allowances.

7 **The least number of parts per pump and the maximum interchangeability of parts between sizes.** Six sizes with all parts interchangeable except case, end cover and impeller.

8 **Extra heavy shaft and bearings** with running clearance easily adjusted for maximum efficiency.

9 **Discharge nozzle** is vertical and is located at center of pump for venting and to simplify piping.

10 **Minimum floor space** required.

NATIONAL TRANSIT PUMP AND MACHINE CO.

Home Office and Works, OIL CITY, PENNA.

CHICAGO, 624 South Michigan Ave. • CLEVELAND, 702 Marshall Building • HOUSTON, Room 522 West Building
SAN FRANCISCO, 607 Market St. • NEW YORK, 30 Rockefeller Plaza • PHILADELPHIA, 2324 Fidelity Phila. Trust Bldg.
PITTSBURGH, 912 Farmers Bank Building • TULSA, 318 East Archer • LOS ANGELES, 2068 East 37th Street

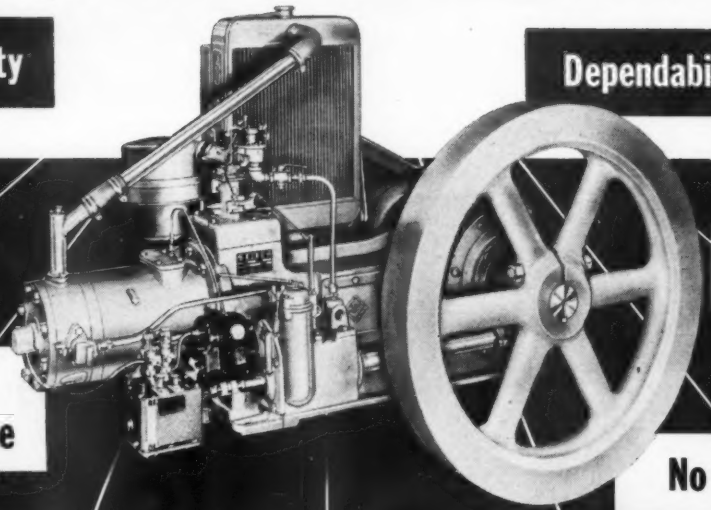
XUM

Every performance quality

ON A MIGHTY FIRM FOUNDATION!

Simplicity

Dependability



Long Life

Economy

Low Maintenance

No Sludge

Ajax GAS and OIL ENGINES

The features of the Ajax engine are those desired by experienced production men in the oil industry. Designed and built with the sole purpose of best serving oilfield requirements, Ajax Engines benefit by complete specialization—and users benefit everywhere by the truly exceptional stamina and operating economy of these reliable units. *Write for technical literature.*

Ask your supply man for the facts!

AJAX ENGINES

AJAX IRON WORKS

Manufacturers of Gas Engines • Steam Drilling Engines • Industrial Steam Engines

CORRY, PENNSYLVANIA

Oil Field Distributors: THE NATIONAL SUPPLY CO., TOLEDO, O. R. B. MOORE SUPPLY CO., INC., BOLIVAR, N.Y.
BETHLEHEM SUPPLY CO., TULSA, OKLA.

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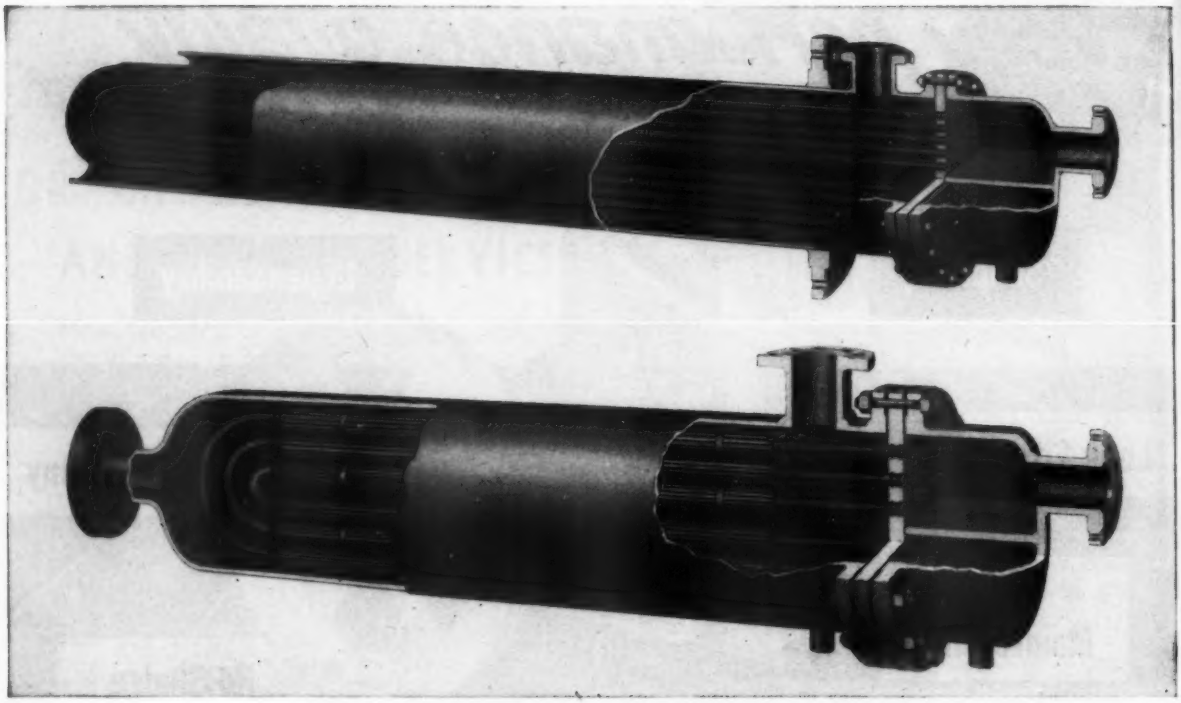


BROWN FINTUBE

Tank Suction Heaters and Line Heaters

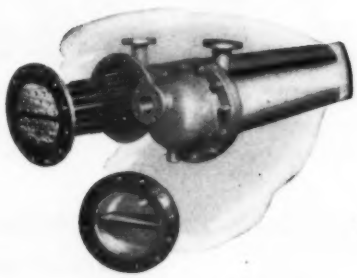
● Brown Fintube Tank Suction Heaters are moderately priced and highly efficient. They heat viscous oils so that they can be pumped more easily, and bolt or weld to a tank nozzle, or directly to the tank shell, so all piping and connections are made outside the tank.

The Line Heaters are used as Suction Heaters to permit easier pumping of viscous oils; — or as Pressure Heaters, either to overcome temperature losses in long lines, or to preheat liquids for further processing.

In all cases the bundles consist of Brown Fintube hairpins rolled into the tube sheet in full compliance with the ASME codes. Metal bands, placed around alternate fintubes, prevent the longitudinal fins from interlocking and restricting the flow. This construction avoids baffling, and permits the liquids being heated to pass through the bundle *unobstructed,* in close contact with the fins and center tubes, with *low pressure drop.* Wide range of standard sizes.

Send for Bulletin No. 482. It gives full details.
Let us quote on your requirements.

Brown Fintube Hairpin Bundles Showing the Banding of Alternate Tubes that Eliminates Baffles and Assures Unobstructed Flow.



Hairpin Bundle Assembled in Shell Showing Mounting of Tube Sheet Between the Shell and Head.

THE BROWN FINTUBE CO.
ELYRIA, OHIO

FINTUBE HEAT TRANSFER PRODUCTS

LET PB TAKE THE WHIPPING!

YOU KNOW THE RESULTS of excessive vibration and whip in the fast line of your rig . . . how line wears out quicker because of uneven spooling and pile-up on the drum and unnecessary friction against the fast sheaves. *PB can save you money by taking the whip out of the wire line on any well you drill.*

NEW PB ROLLETTE WIRE LINE GUIDE

FOR ALL AVERAGE DEPTH DRILLING

8-POINT CONTACT! Eight rollers contact the line, stabilize it against damaging whip and vibration, and insure even line spooling on the drum.

ABSORBS WHIP! All line whip absorbed by the rollers is transmitted to the Rollette body and hanging assembly.

NON-CLOGGING! Rollers of solid, tough, field-proven PB rubber operate in an all-steel body designed so that rollers cannot clog or throw oil on the crew.

FREE SPINNING! Rollers are molded integral with heavy duty lubricated-and-sealed ball bearings that insure a free-running line at all times.

SAFE! Rollette design and construction are such that the rollers cannot, under any conditions, fall out of the body.

FOR YOUR DEEP DRILLING

use the PB Roliguide, especially built for the heaviest duty deep drilling operations. Handles 1½" wire line, has all the construction features you want for the toughest well conditions.

Your nearby PB representative has detailed information on the new PB Rollette Wire Line Guide, supplied complete as pictured, made to meet *most* of your drilling requirements. *See him today.*

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BETTER MECHANICS PREFER

TOLEDO 1R THREADER

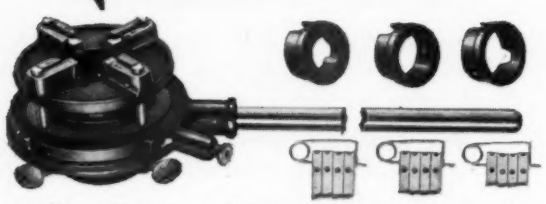
FOR 1" to 2" PIPE

because

It's ACCURATE!
Perfect threads produced by separate Toledo Dies for each pipe size.

It's EASY THREADING!
Less friction due to famous Toledo receding die principle—small die segments with only a few cutting teeth backed by taper pins.

It's LOW COST!
Simple in design with one ratchet handle.



Do your next 1" to 2" pipe work with a Toledo 1R Threader—the tool that's "tops" with better mechanics! Similar to the famous No. 1 and No. 1A Toledos—but *simpler in design* with one ratchet handle and *low in cost!* A separate set of dies for each size of pipe —1", 1¼", 1½" and 2"—assures longer die life. Each set is hobbed for just the proper clearance. This means easier cutting, smoother, cleaner, more perfect threads and tighter pipe joints! Die change is quick and easy . . . or, many users prefer separate tool for each size. Durable . . . saves job-time . . . reduces costs! Ask your distributor for details and price . . . or send coupon.

SEND COUPON

The Toledo Pipe Threading Machine Co.
Toledo, Ohio
Without obligation, send bulletin No. 650 and price on Toledo No. 1R Threaders, 1" to 2" pipe.

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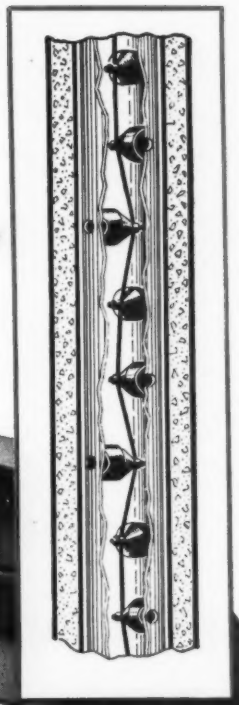
City.....State.....

RELY ON THE LEADER **TOLEDO**

PIPE TOOLS . . . POWER PIPE MACHINES . . POWER DRIVES

The most effective perforating tool the oil industry has ever known...

DU PONT JET PERFORATORS!



Du Pont Jet Perforators are high-explosive charges designed specifically to cut through oil-well casings and sheath and to penetrate the surrounding formation. Precision manufacture and quality control by Du Pont make them the most efficient means of perforating yet developed . . . assure uniform action and predictable results in the field.

Easy to work with

"Jets" are loaded in leak-proof carriers ready to lower into the well upon arrival at the job site. This pre-loading speeds operations by reducing rig time as much as 50%. And since one or more carriers can be fired simultaneously, symmetrical patterns are assured.

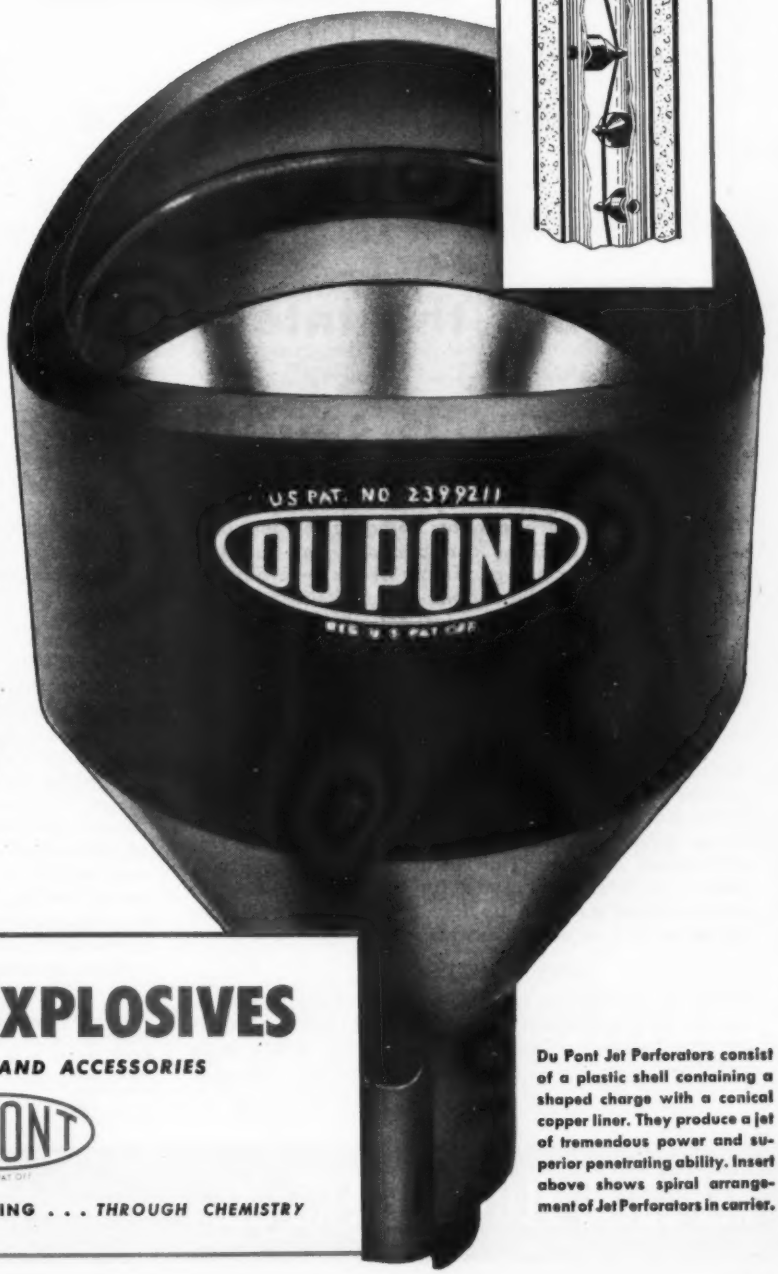
Perforate to maximum depth

Du Pont Jet Perforators readily perforate one, two or three strings of casings . . . give up to three times deeper penetration than other methods. They leave no obstructions in the casing to interfere with the lowering of tools through the perforated zone. And they maintain maximum performance with well temperatures up to 350°F.

New bulletin tells how they work

It's to your advantage to have your service company use Du Pont Jet Perforators on your next job. Write now for your copy of informative bulletin describing the action of Du Pont Jet Perforators.

E. I. du Pont de Nemours & Co. (Inc.)
Explosives Department
Wilmington 98, Delaware



Du Pont Jet Perforators consist of a plastic shell containing a shaped charge with a conical copper liner. They produce a jet of tremendous power and superior penetrating ability. Insert above shows spiral arrangement of Jet Perforators in carrier.

DU PONT EXPLOSIVES

BLASTING SUPPLIES AND ACCESSORIES

DU PONT

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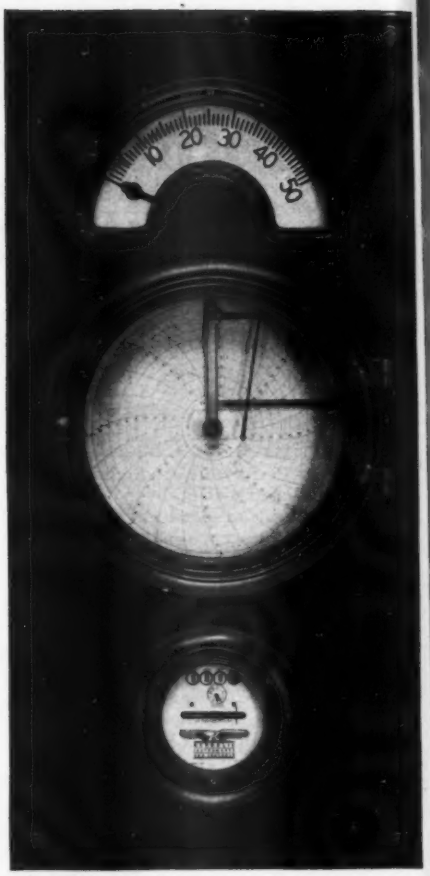
Integrator

Varying flows are accurately totalized because the integrator is continuous



Indicator-Recorder-Integrator

The Republic flow integrator, being of the modified watt-hour type, totalizes continuously—not intermittently. It operates independently of the recorder and its accuracy is not dependent on or affected by any clock mechanism or mechanical action.

The Republic meter is, on this account, peculiarly fitted to follow all changes in flow rate and accurately measure highly fluctuating flows.

ALL TYPES OF FLUIDS

Republic electric type flow meters are available for measuring the flow of all types of liquids and gases. Meter bodies are built for metering fluids at line pressures up to 5,000 lb. per sq. in. and for all ranges of differential pressure. The reading instruments—indicator, recorder and integrator—are of the remote reading type and can be located any distance from the point of flow measurement.

ANY COMBINATION

While each Republic reading instrument is standard in design and construction each is especially calibrated for the particular flow measurement for which it is specified. Any reading instrument, indicator, recorder or integrator, may be obtained separately or in any combination desired, making possible the highest degree of flexibility in plant use.

SIMPLE IN OPERATION

The Republic electric meter is the only flow meter commercially manufactured which is strictly electric in its operation. All other types of so called electric meters use the motion of the mercury to move a float or produce a force which is then converted into an electrical value which is in turn transmitted to a receiving or reading instrument. In the Republic meter, the transmitted electrical value is determined directly by the mercury motion, thus eliminating one of the steps in the sequence, and simplifying the mechanism to that extent. There are no floats, levers, cams, rotating shafts or anything else to interfere with the unimpeded movement of the mercury, which has no work to perform, but merely fulfills the function of making contact.

NEW DATA BOOK

Just off the press—a completely new data book describing and illustrating, in detail, the operating features of the Republic Flow Meter and its many applications. Write for your copy of Data Book No. 702—there is no obligation.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS

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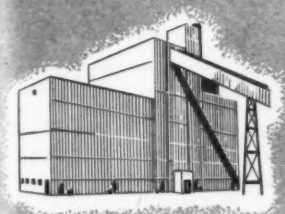
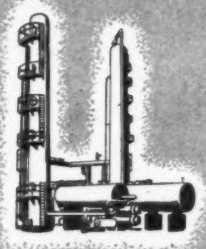


POWER DIVISION



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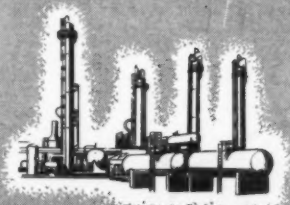
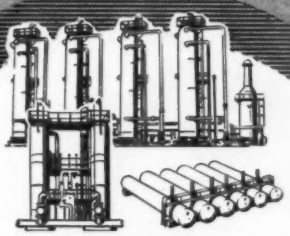
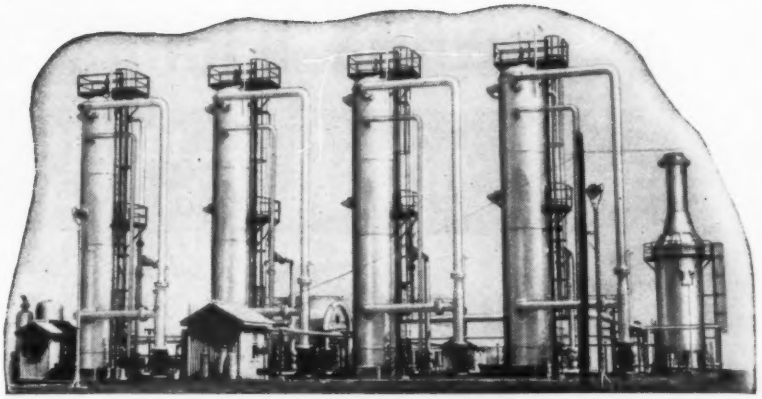


PETROLEUM DIVISION



NATURAL GAS DIVISION

DESIGN ENGINEERING and CONSTRUCTION for INDUSTRY



Natural Gasoline Dehydration Plant with a daily capacity of 300,000,000 SCF at 1000 psig, recently designed and engineered by Pritchard.

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For the most modern advancements in design, engineering and construction — to assure plants that produce higher profits and give trouble-free operation—consult J. F. Pritchard & Co. Pritchard-built plants are well known for their operational efficiency and quality of production.

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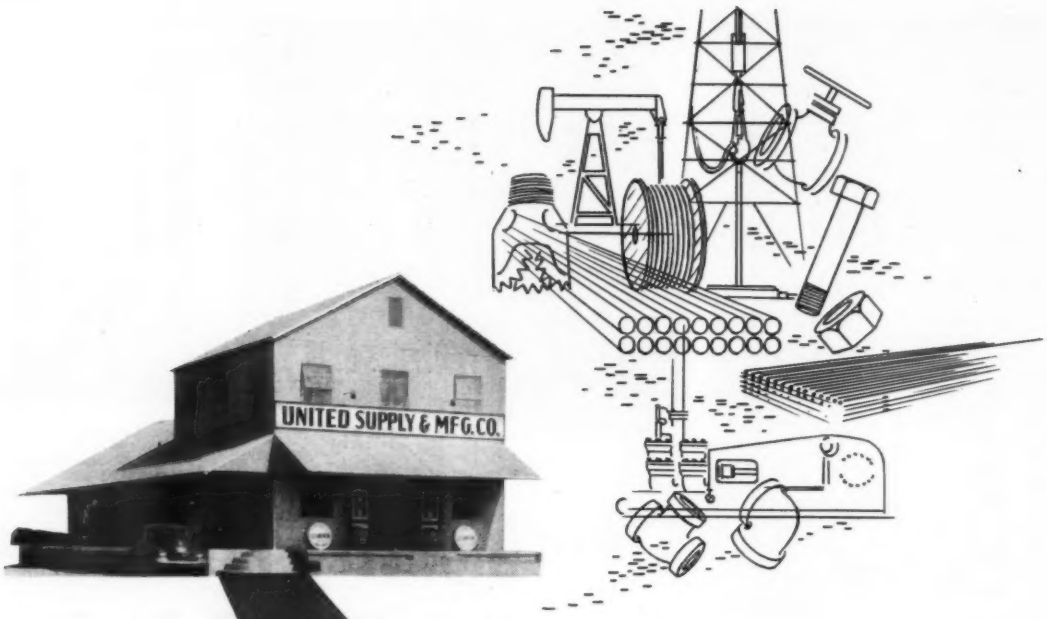

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FACTS YOU SHOULD KNOW . . . about

G-E 2-Way Radio

NARROW BAND vs. WIDE BAND

• Narrow band equipment (20 kc channels in the 25-50 mc band) is ALLOCATION INSURANCE. It is almost inevitable that future geographical assignment plans made by industry advisory groups will be drawn up on a 20 kc channel separation basis. Installation of 20 kc equipment NOW protects your system against interference from same-area stations 40 kc off your own frequency and from skip signals only 20 kc removed from your channel. It would be to your advantage to consider a change-over now.

Extended field and lab tests show:

1. There is no discernible difference in communication range between 20 kc and 40 kc systems.
2. Lower multiplication factor in 20 kc transmitters means substantial reduction of spurious radiations.
3. Signal-to-noise ratio differences in high signal level areas are insignificant.

• You'll find more true, high-selectivity General Electric 20 kc units in service than all other makes combined. And G. E. also manufactures high-performance units for expansion of present systems where continued operation on a 40 kc channel basis is desired.

Instant communication for wide-area operations is our specialty. There's a radio communication representative at the G-E office near you. Ask him for full details. Meanwhile, write for some interesting new literature on microwave equipment: General Electric Company, Section 870-27, Electronics Park, Syracuse, New York.

GET THIS BULLETIN—Bulletin X55-752 is important to every communications engineer. Write for your copy: *General Electric Company, Section 870-27, Electronics Park, Syracuse, New York.*

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Many wire rope users who keep an eye on their operating costs have proved by the accurate yardstick of performance that "HERCULES" (Red-Strand) Wire Rope provides longer wear . . . faster and more *continuous* work . . . increased profit.

Such results are never a matter of chance; definite policies involving materials, manufacturing methods, equipment and experience, insure them.

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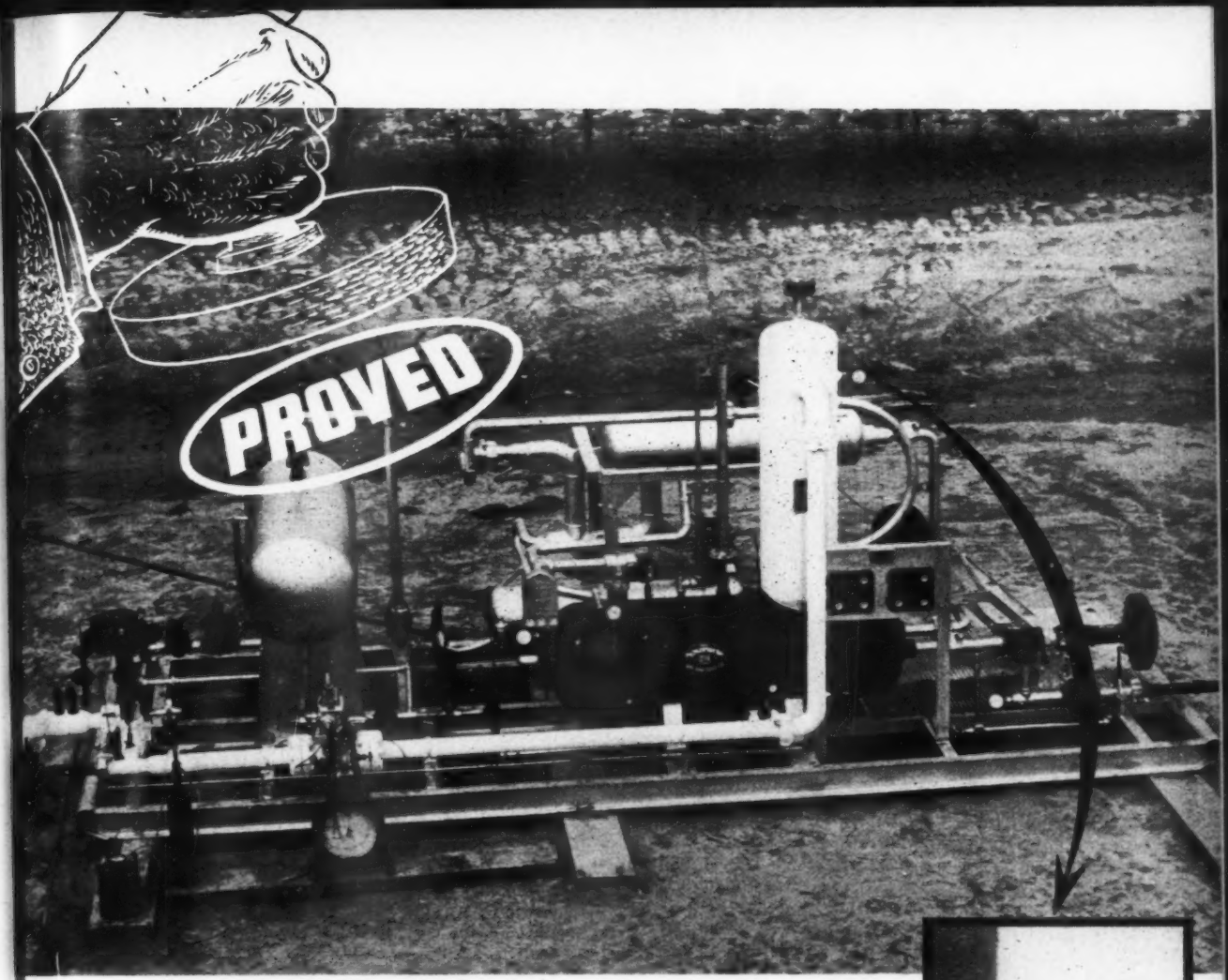

PARKERSBURG HYRECO PROCESSING UNIT

will recover more condensate

Its being done every day on well after well by the Hyreco Processing Unit. With extremely low temperature of gas in the high-pressure separator . . . occasionally zero and lower . . . the Hyreco Unit covers more liquid hydrocarbon per cubic foot of gas produced than any other well head process known today.

Hyreco Processing Units have increased liquid hydrocarbon recovery from 15% to 25% . . . have upped net earnings from condensate sales as much as $900.00 per month . . . have paid out in a few months, are now paying extra dividends monthly. Absence of heaters saves operating cost and troubles, abolishes fire hazard. Elimination of expensive down time due to freezing gas lines is still another important saving.

Compare performance records. Ask your Parkersburg Representative for factual data about the Hyreco Processing Unit. Write for bulletins HR-550 and HR-650.

This Hyreco Unit is operating perfectly with gas inside separator at one degree above zero! Separator and outlet gas line are heavily coated with ice and frost. This installation is entirely free of freezing troubles, evidence of how completely and efficiently all liquid water has been removed from the gas stream before reaching the high pressure separator.

5012

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RIG & REEL COMPANY • Parkersburg, West Virginia

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Twin Disc Clutches *on this job, too!*

Twin Disc Model CL Clutch.

There are four Twin Disc Model CL Clutches in the Winter-Weiss Portadrill transfer case. The Portadrill is used mainly for exploratory drilling and shallow oil production.

Exploratory drilling calls for speed . . . portable rigs that must move fast and drill fast.

Fast drilling demands a fast-acting clutch . . . like Twin Disc's Model CL. The CL is a heavy-duty friction clutch, yet small and compact . . . designed for high-speed installations demanding easy engagement and disengagement.

Overall dimensions are held to a minimum to conserve space. Action parts are hardened and ground. Wide friction surfaces are used. High grade molded asbestos friction material and highly finished surfaces on the clutch plates reduce wear to a minimum and assure smooth positive operation.

Twin Disc Model CL Clutches are available in one, two and three plate models, 5.5″ to 11.5″, with working capacities ranging from 12 to 125 hp. For complete information, write for Bulletin 120-C. TWIN DISC CLUTCH COMPANY, Racine, Wisconsin (Hydraulic Division, Rockford, Illinois).

Clutches & Hydraulic Drives

TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES

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FOR DRILLING TO 10,000 FEET with 4½" drill pipe

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B-85 DRAWWORKS

WITH CONSOLE CONTROL

Wheland rotary equipment to match the B-85 drawworks:

HP-14000 7½ x14 350 HP Slush Pump
A-20 . . . . 20½ inch Table Top Rotary
K-2500 . . . . . 250 ton Traveling Block
E-6600 . . . . 350,000 lb. cap. Swivel

COMPACT

FAST

QUIET

EASILY PORTABLE

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PRESSURE FEED LUBRICATION

This New, Field Proven Wheland Drawworks Makes the Driller King of All He Surveys!

Never before has the driller had such easy and positive control over all drilling operations! With this new Wheland drawworks he can see the whole rig, control drilling operations accurately, quickly, easily.

4 Advantages of WHELAND CONSOLE CONTROL

1. EASY—All controls grouped at driller's fingertips.
2. SAFE—Console may be located in safest areas. Driller can easily see every part of the rig.
3. FAST—Controls respond instantly to a touch of the finger.
4. EFFICIENT—The weight carried on the bit and the speed of rotation are easily controlled.

This field proven Wheland drawworks with console control gives the driller control, visibility and safety never before available in drilling equipment. It is chock full of new performance and convenience features . . . For example: The feed-off characteristics of the Wheland air brake are similar to those of an automatic driller. Metering valve in air system allows minute adjustments in brake application. The rugged 750 HP transmission has forged steel shafts, forged steel, cut tooth, flame hardened sprockets and chain drives designed with a generous safety factor for smooth, trouble-free performance. Precision roller bearings throughout. Pressure feed lubrication . . . Get the whole story on this revolutionary new Wheland drawworks! Ask for free bulletin or

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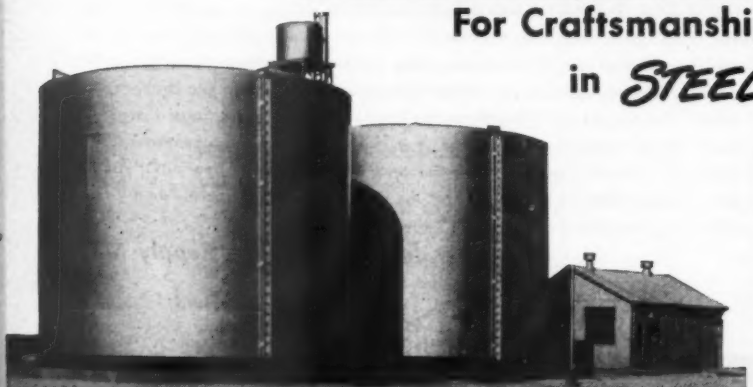

Spheres for storage of volatile liquids under pressure . . . flat-bottomed, cone roof tanks for liquid storage at atmospheric pressure . . . engineered, fabricated and erected to the most exacting standards, employing any required metal or alloy. Use Pittsburgh-Des Moines' experience and special research facilities in determining the storage units best suited to your needs—*write for an early consultation.*

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This Simple Compressor Meets the Complex Needs of a Changing Petroleum Industry

It's the Nash!

Here is a compressor presenting advantages found in no other device. Nash Compressors have only one moving part, rotating without metallic contact with the pump casing. No internal lubrication is required. Yet they produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure.

There are no valves, gears, pistons, sliding vanes, or other complicated wearing parts in a Nash. Compression is secured by an entirely different principle of operation. Because of this, gas pumping problems difficult with ordinary pumps are often easily handled by the Nash. For example, Nash Pumps are standard equipment in the Synthetic Rubber Industry, where they have met the needs of new and difficult processes.

Nash Compressors are compact and save space. They run without vibration, and compression is without pulsation. They maintain original performance over long periods. Service is assured by a nationwide net-work of Engineering Service offices. Instructive bulletin shows how they operate. Write for it.

One moving part.

No internal wearing parts.

No valves, pistons, or sliding vanes.

No internal lubrication.

Low maintenance.

Slugs of liquid entering pump do no harm.

Non-pulsating pressure.

Saves floor space.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

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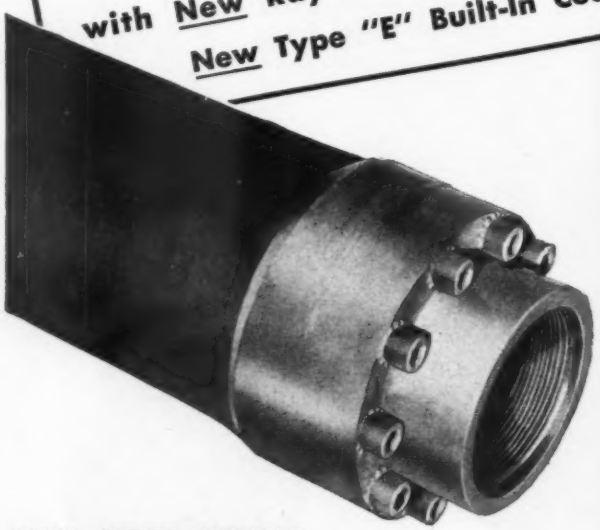
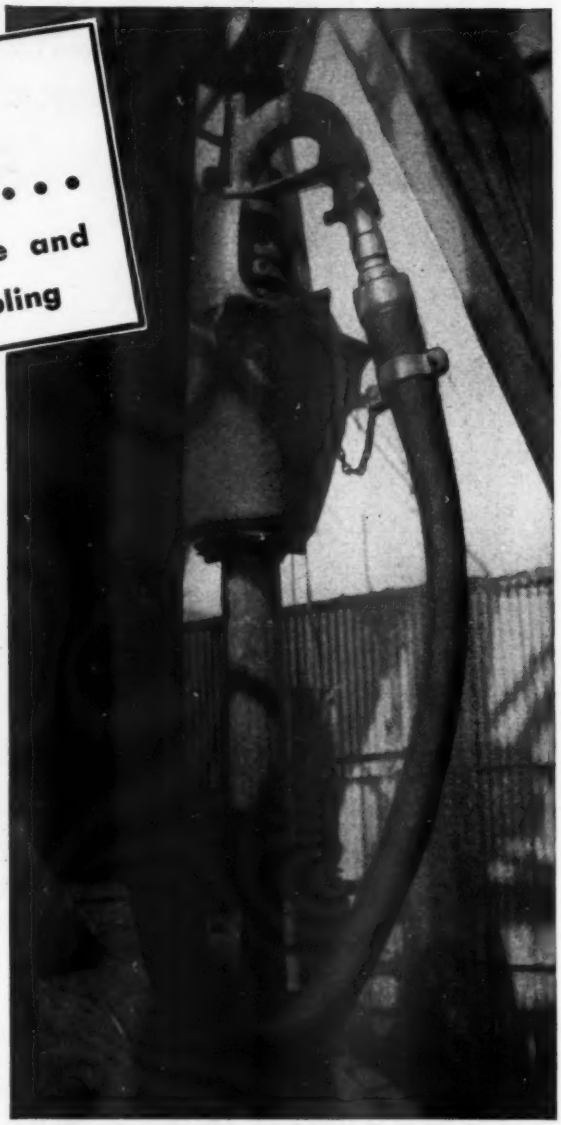
QUICK PAY-OFF . . .
SLOW WEAR-OUT . . .

with New Ray-Man Rotary Hose and New Type "E" Built-In Coupling





NEW, MORE FLEXIBLE HOSE CONSTRUCTION DRILLS MORE HOLE—

Quality and design of the rotary hose play the most important part in long hose life. Ray-Man Rotary Hose is built on an entirely new principle. It has more flexibility and holds steadier in the derrick under the high pressures of deeper drilling than any other hose. Ray-Man Rotary Hose is also lighter in weight, which means easier make-up, less damage in trucking. It features Manhattan's Flexlastic Oil-Proof tube for drilling with regular mud or oil-base mud. We know from recent field records that Ray-Man Rotary Hose drills "more hole per length" than has ever been accomplished with old style rotary hose.

NEW, BUILT-IN LEAKPROOF COUPLING

Manhattan's development of the streamlined, built-in Type "E" Rotary Hose Coupling is lowering hose costs in all oil fields. The "LIP-LOK" Pressure-Sealing Flange in this new coupling insures against costly, dangerous leaks and blowouts. There are no protruding lugs or flanges. This new coupling never needs adjustment or tightening—because it's a *Built-In*, integral part of Ray-Man Rotary Hose.

Ray-Man is made for 5,000-lb. test pressure. Paranite is the same type, made for 4,000-lb. test pressure. Buy these MANHATTAN constructions for more footage —lower hose costs.

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AVOID MECHANICAL SHUTDOWNS!

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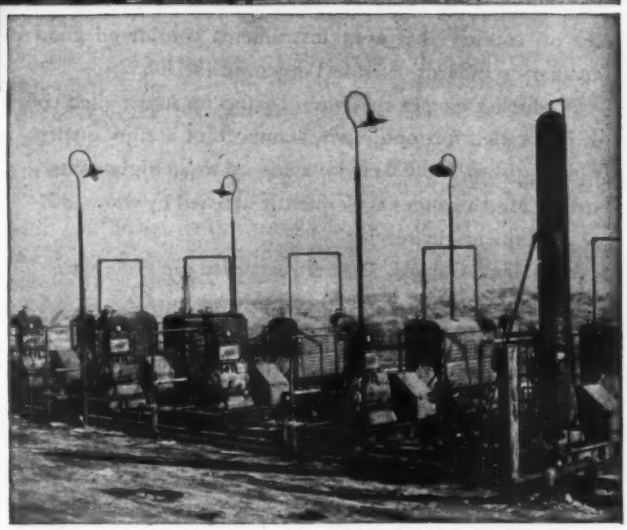
POWER UNITS

SUPPLY DEPENDABLE, LOW COST POWER



The surest way to maintain steady high-level production is through dependable uninterrupted power. Minneapolis-Moline engines for oil field power have built an enviable record for continuous duty without mechanical shutdowns.

Low cost installations of MM heavy-duty engines that provide 25 to 230 h. p. offer exceptional maintenance economy and long engine life. In addition you get these MM exclusive features: *crankcase ventilation, heat exchanger base pans, high-turbulence combustion chambers, regulated cooling, by-pass thermostats, removable cylinder heads and blocks, extra large bearing surfaces, replaceable bearing shells that are steel-backed and precision made, water-cooled manifolds,* and many others.

You, too, will agree that Minneapolis-Moline engines are quality constructed and skillfully engineered for heavy-duty performance in oil field operations.

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MINNEAPOLIS 1, MINNESOTA

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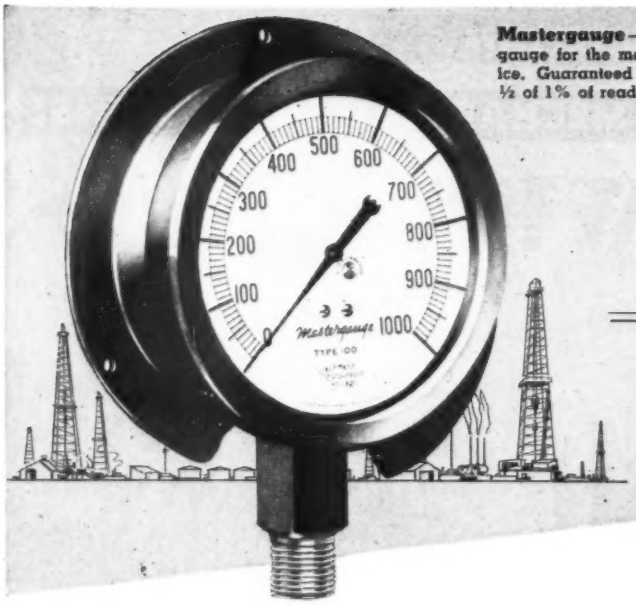
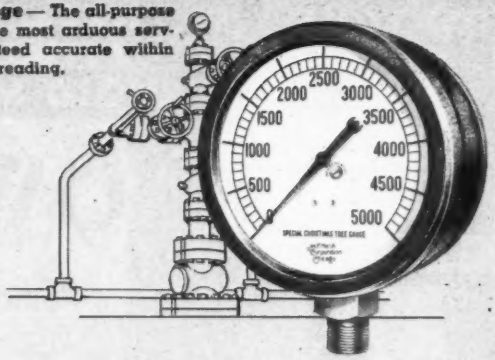
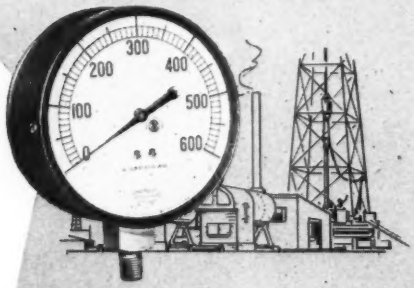


Mastergauge — The all-purpose gauge for the most arduous service. Guaranteed accurate within ½ of 1% of reading.



Christmas Tree Gauge — Specially made for Christmas trees. These gauges incorporate ruggedness and accuracy beyond all others.



Oil Country Boiler Gauge — The mastergauge specially made for oil country boilers.

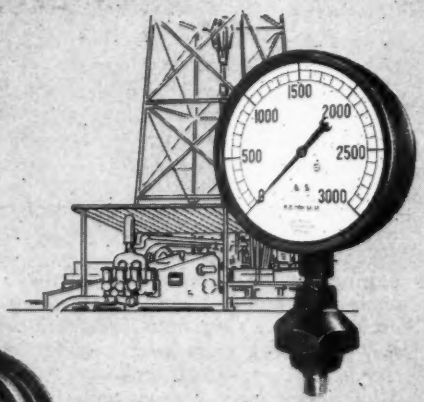
Instruments that set their own standards

So tough are the demands imposed upon pressure gauges in the oil country that even instruments considered good by ordinary standards often fall down on the job.

Producing gauges that would stand up under such conditions called for totally new standards of design, quality, workmanship. How well we achieved these higher standards in Marsh gauges is eloquently attested by thousands of instruments in service.

Yes, Marsh Gauges have been accorded top preference in the petroleum industry because they have set new standards all their own.

Ask for bulletins describing Marsh Gauges specifically designed for the oil industry.



Mud Pump Gauge — The Mastergauge with protecting diaphragm of advanced design.

Hydraulic Gauge — Finest of hydraulic gauges in pressure ranges up to 30,000 lbs. per sq. in.

MARSH INSTRUMENT CO.
Sales affiliate of Jas. P. Marsh Corporation
Dept. L, Skokie, Ill.
HOUSTON BRANCH PLANT: 1121 Rothwell St.
Sect. 15, Houston, Texas

The Marsh branch plant at Houston offers shipment from stock and facilities for repairing all makes of gauges.

MARSH GAUGES

XUM

These "Cats" get Longer Life

Panhandle Refining Co., Wichita Falls, Texas.

Engineered Air cuts refiners' costs

REFINING petroleum, just as the term implies, means getting rid of impurities. Even the catalytic compounds have to be kept clean and that meant frequent replacement of catalysts . . . expensive but necessary.

Engineers reasoned a good way to stop contamination of costly catalysts was to catch dirt at the start—capture it at the air intake.

Because AAF makes every kind of air filter, expressly for particular air cleaning problems, those catalysts have longer life now. In the picture above you see AAF Type OCH on the job. Six units in the housing behind those weather louvres maintain a strict "keep out" attitude toward air borne dirt. Filters can be taken out, cleaned quickly and replaced.

The catalytic process functions better with clean air. The catalytic compound stays in service far longer, saving dollars for the refiner.

AAF equipment can be on the job for you. Why not call in the air experts, let AAF find a "profit in the air" for you. Just write to the address below.

HERE'S A QUICK TEST IN GOOD MANAGEMENT FOR YOU

Where can you stop a dollar loss? Is dirt in your engines, in your plant, on your product, costing you money? Check up right now. See how you can profit from clean air.

AIR FILTERS
AND DUST CONTROL EQUIPMENT

AAF
American Air Filter
COMPANY, INC.

444 Central Avenue, Louisville 8, Ky., *In Canada: Darling Bros., Ltd., Montreal, P. Q.*

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WAGNER MOTORS
...The choice of leaders in industry

Wagner Motors speed oil from tank to tanker

From the oil refineries of the Southwest, come a steady flow of the petroleum products that are the life blood of modern industry. The 100 horsepower Wagner explosion-proof motor, shown in the photograph above, plays a part in maintaining this flow—it is located in the docking area of one of these refineries—and pumps oil from the supply tanks to the docks for loading on oil barges and vessels.

Wagner explosion-proof motors are a familiar sight in the great refineries and oil fields of the nation. There's a reason—these time-tested motors of the oil fields are particularly designed for *safe,* dependable operation in explosive atmospheres. They are fully protected against dust, sand, rain and snow—and they are always reliable.

This application is but one of thousands where specialized requirements are met from the complete line of Wagner standard motors. Bulletin MU-185 gives information on Wagner Motors, write for your copy.

Wagner engineers are qualified to specify the correct motor for *your* needs. Consult the nearest of our 31 branch offices, or write us.

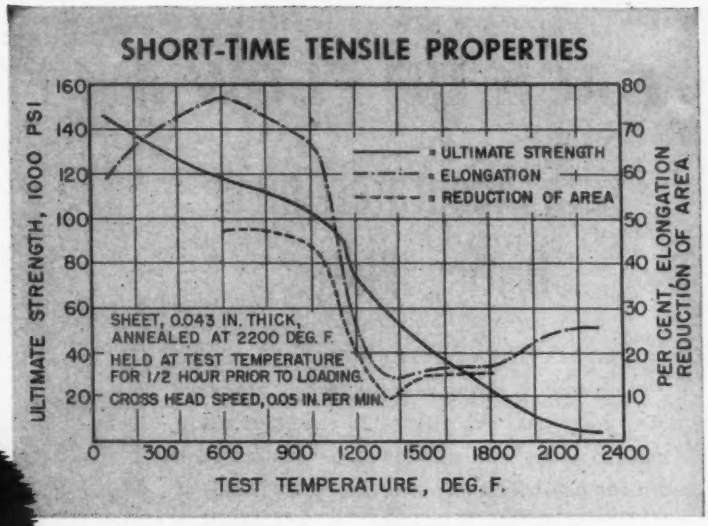
Wagner Electric Corporation
EST. 1891

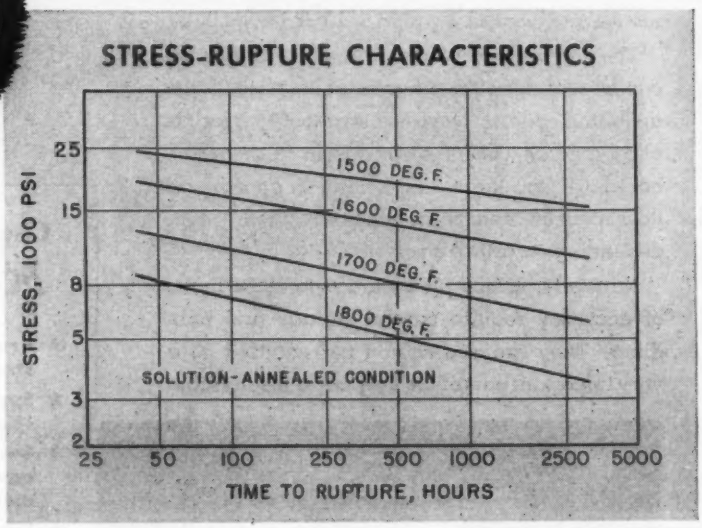
ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS — AIR AND HYDRAULIC

WAGNER ELECTRIC CORPORATION
6389 Plymouth Ave., St. Louis 14, Mo., U.S.A.

BRANCHES IN 31 PRINCIPAL CITIES

HAYNES
TRADE-MARK
Alloy No. 25


SHORT-TIME TENSILE PROPERTIES
ULTIMATE STRENGTH, 1000 PSI
PER CENT, ELONGATION REDUCTION OF AREA
= ULTIMATE STRENGTH
= ELONGATION
= REDUCTION OF AREA
SHEET, 0.043 IN. THICK, ANNEALED AT 2200 DEG. F.
HELD AT TEST TEMPERATURE FOR 1/2 HOUR PRIOR TO LOADING.
CROSS HEAD SPEED, 0.05 IN. PER MIN.
TEST TEMPERATURE, DEG. F.



STRONG up to 1800°F. without aging

DUCTILE at room temperature

HAYNES alloy No. 25 is a new wrought high-temperature alloy that has exceptional mechanical properties at temperatures up to 1800 deg. F.—*in the fully annealed condition without subsequent aging*. Yet this alloy is *easy to fabricate* because it has excellent ductility at room temperature. This combination of properties makes HAYNES alloy No. 25 an ideal material for the construction of highly stressed parts that must operate at elevated temperatures.

This latest addition to the series of HAYNES high-temperature alloys was developed as a wrought material to withstand a minimum stress of 6,000 lb. per sq. in. for 100 hours at 1800 deg. F. It is available as sheet, plate, bar stock, and tubing.

Consult our nearest office for engineering data and assistance in solving your high-temperature problems with HAYNES alloy No. 25. Physical and mechanical properties of the other 9 HAYNES high-temperature alloys are given in tabular and graphic form in the booklet, "HAYNES Alloys for High-Temperature Service." Data on short-time tensile properties, stress-rupture, creep test, endurance properties, and fabrication procedures are included. Write to Haynes Stellite Division, UCC, 717 S. Lindsay St., Kokomo, Ind.

Haynes Stellite Division
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

HAYNES
TRADE-MARK
alloys

The trade-mark "Haynes" distinguishes products of Union Carbide and Carbon Corporation.

XUM

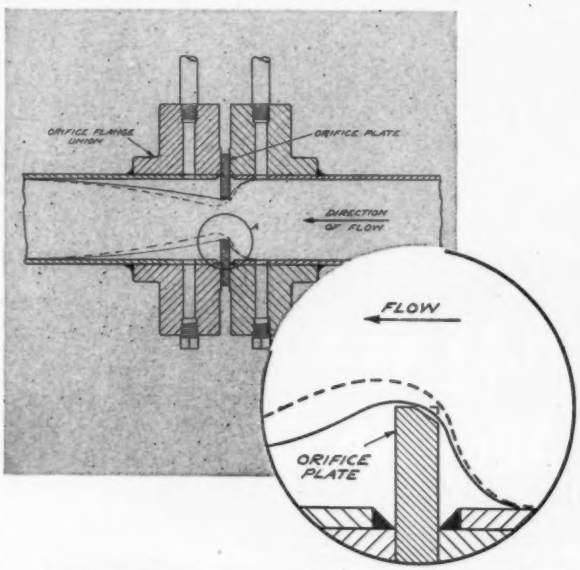
BACK UP FLOW METER ACCURACY

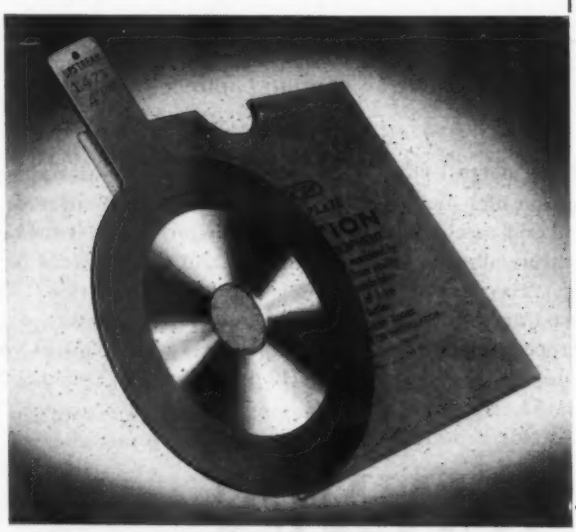
with Accurately-made Orifice Plates

THE PRECISION TOLERANCES of Foxboro Orifice Plates may seem extreme, but results over the years have paid off in worthwhile savings to users. These thin-plate, square-edge orifices are bored to an accuracy of 1/20th of 1% of the orifice diameter . . . which means a measuring accuracy within 1/10 of 1% (0.001).

The importance of the *square* leading edge can be seen from the diagram at the right. If the upstream edge of the orifice is dulled to a radius of as little as .005", it's equivalent to an orifice bored .01" too large . . . resulting in an error in flow measurement of as much as 2% or more, depending on orifice size.

Naturally, orifice plates made to close limits of accuracy require careful storage and handling. They are and should be regarded as a very important part of the flow meter installation.





Check these Advantages of FOXBORO Orifice Plates

Reg. U. S. Pat. Off.

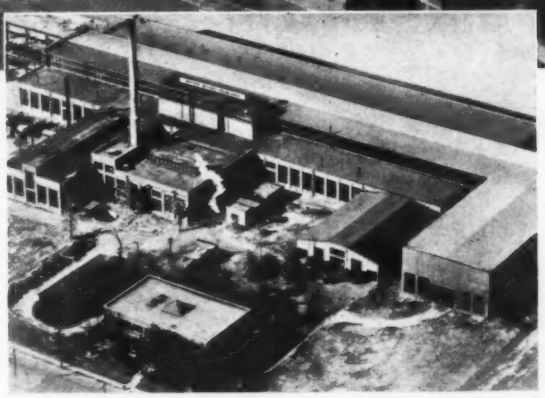
- ★ **Precision bored, with square upstream edge, for maximum accuracy**
- ★ **Supplied in metal best suited to specific service conditions**
- ★ **Bored plates enclosed in individual envelopes for protection during shipment and storage**
- ★ **Easy to install between union flanges**
- ★ **Data always visible on projecting tabs**
- ★ **Low in cost**

Write, giving available details of your metering problem, for further details on Foxboro Orifice Plates. (Foxboro also furnishes flow nozzles, Venturi tubes, and Pitot tubes, whenever requirements call for these alternative primary elements.) We'll gladly send bulletin which describes Foxboro Flow Meters as well. Address: The Foxboro Company, 40 Neponset Ave., Foxboro, Mass., U. S. A.

FOXBORO ORIFICE PLATES

REG. U. S. PAT. OFF.

Shown here are two of the six Combustion manufacturing plants. Chattanooga Plant No. 1 (above) and the St. Louis Plant (right) are devoted chiefly to the production of C-E boilers and pressure vessels.



Equipped WITH EVERY FACILITY

for building boilers and pressure vessels

The fabrication of pressure vessels requires manufacturing facilities and methods identical with those required for building boilers. As one of the world's largest boiler manufacturers, Combustion Engineering—Superheater is, therefore, exceptionally well equipped to build virtually all types of pressure and vacuum vessels.

That the oil industry recognizes Combustion as a reliable source of such equipment is evidenced by the fact that we have produced literally thousands of towers, drums, tanks, stills—in fact, refinery vessels of all types and sizes—for many of the leading companies in the industry. We shall welcome the opportunity to bid on your requirements.

In addition to pressure vessels, Combustion offers you the well-known Vertical-Unit Boiler, likewise widely known and highly regarded in the refinery field. VU Units with an aggregate capacity of nearly 12,000,000 lb of steam per hr are presently installed or on order for the oil industry. The VU-50 Boiler enables the average plant to achieve a standard of economic performance closely approaching that obtained in large central power stations and is available in capacities up to 350,000 lb of steam per hr, pressures to 1000 psi and total steam temperature to 900 F and above. For plants having small operating and maintenance personnel, Combustion offers the VU-10, available for capacities from about 10,000 to 50,000 (or more) lb of steam per hr with pressures up to 480 psi. Investigate the Vertical-Unit Boiler when next you are in the market for steam generating equipment. B-337

C-E

COMBUSTION ENGINEERING—SUPERHEATER, INC.

A Merger of Combustion Engineering Company, Inc. and The Superheater Company

200 Madison Avenue • New York 16, N. Y.

PRODUCTS FOR THE REFINING INDUSTRY INCLUDE STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; ALSO PRESSURE AND VACUUM VESSELS

XUM

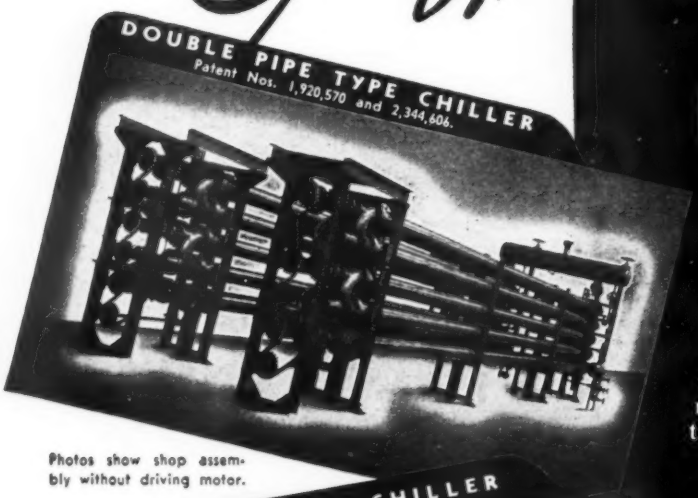
If you're all "gummed up" in a tough heat transfer problem

Specify..

Vogt Spiral, Spring Type Scraper
Patent No. 2,117,175

Vogt

SCRAPER TYPE CHILLERS



Photos show shop assembly without driving motor.

Fouling of the inner pipe surfaces of Vogt Chillers is eliminated, because they are swept clean continuously during operation by patented spiral, spring type scrapers. And these clean surfaces achieve the highest possible rate of heat transfer between the solution and the refrigerant.

VOGT DOUBLE PIPE TYPE CHILLERS are designed to use ammonia, brine, or cold dewaxed oil as the cooling medium. Oil or brine, when employed, is circulated through the jacket pipes countercurrent to the flow of the solution in the inner pipes.

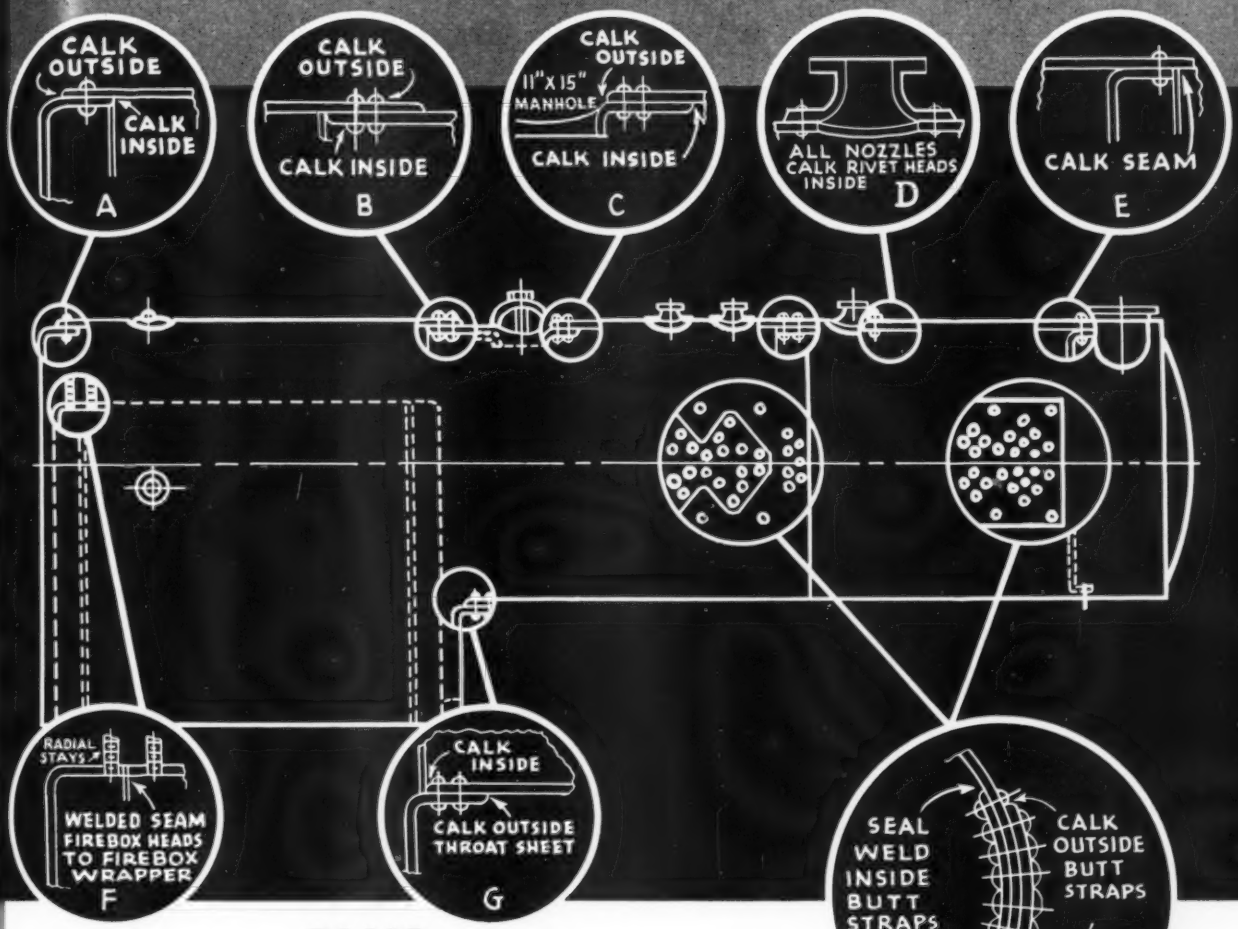
MULTI-PIPE TYPE CHILLERS, for direct expansion, have large jacket shells each containing seven inner pipe sections and employ volatile refrigerants such as ammonia, freon, propane, etc.

Our engineering staff is qualified by training and experience to help you find the right answers to your heat transfer problems. Their recommendations are available without obligation.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS

LUCEY *First* AGAIN!

INSIDE SEAL-WELD AND DOUBLE CALKED BOILER



PLUS

THE OTHER EXCLUSIVE FEATURES AND ADVANTAGES OF LUCEY OIL COUNTRY BOILERS

Lucey is again first with another great improvement in boiler construction — THE LUCEY SEAL-WELDED AND INSIDE CALKED OIL COUNTRY BOILER. Built to far greater care than required by the Boiler Code.

The seams of the inside butt strap are completely welded and peened by an intermittent process approved by the ASME and API codes to prevent metallurgical stress and strain.

Complete double-calking — inside and out — of all joints and rivet heads practically eliminates leakage possibility. With no increase in price, these new and exclusive Lucey construction features are now standard with all Lucey Boilers.

DISTRIBUTORS:

Lucey Products Corporation, Tulsa, Oklahoma
Houston Oil Field Material Co., Inc., Houston, Texas
Jones & Laughlin Supply Co., Tulsa, Oklahoma
Murray-Brooks, Inc., Lake Charles, Louisiana
Bethlehem Supply Co., of Calif., Los Angeles, Calif.

EXPORT:

Lucey Export Corporation, 233 Broadway, New York 7, N. Y.
Broad Street House, E. C. 2, London, England

Lucey Boilers are approved for use in Canada

LUCEY

LUCEY BOILER *and* MANUFACTURING CORPORATION

Chattanooga, Tenn.

BETHLEHEM SUPPLY CO. OF CALIF.
6000 ALCOA AVENUE, VERNON
LOS ANGELES 54, CALIF.

413 STERLING BUILDING
HOUSTON, TEXAS

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LE GRAND

Pumping Units

RUGGED CONSTRUCTION AND PRECISION BUILT THROUGHOUT.

Unit Illustrated is the 25/72.C.C. Model with double helical double reduction gear box.

330,000 lbs. ins. Peak Torque.

Polished Rod Load 25,000 lbs.

Polished Rod Strokes. 24" 36" 48" 60" 72".

LE GRAND SUTCLIFF & GELL LTD

SOUTHALL, MIDDLESEX & ROCHESTER, KENT, ENGLAND

Telephones: Southall 2211 & Chatham 4626 Telegrams: Legrand, Southall Cables: Legrand, Southall Codes A.B.C. 6th Edition

OILFIELD EQUIPMENT MANUFACTURERS & FOUNDERS

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...cks get there
FASTER
...t Lower Cost with...

EATON
2-Speed Truck
AXLES

By combining pulling power and speed, Eaton 2-Speed Axles add to truck utility and permit faster trips, more pay-load miles—on the highway or off. Eaton Axles reduce stress and wear on engines and all power transmitting units. This means longer life and minimum maintenance cost...and Eaton's planetary design adds thousands of miles to *axle* life. Gear tooth loads are better distributed; gear speeds are slow; stress and wear are held to a minimum. Eaton Axles are available for most trucks of 1½ tons and larger. Ask your truck dealer for a road demonstration.

Axle Division
EATON MANUFACTURING COMPANY
CLEVELAND, OHIO

EATON **PRODUCTS:** SODIUM COOLED, POPPET, AND FREE VALVES • TAPPETS • HYDRAULIC VALVE LIFTERS • VALVE SEAT INSERTS • JET ENGINE PARTS • ROTOR PUMPS • MOTOR TRUCK AXLES • PERMANENT MOLD GRAY IRON CASTINGS • HEATER-DEFROSTER UNITS • SNAP RINGS SPRINGTITES • SPRING WASHERS • COLD DRAWN STEEL • STAMPINGS • LEAF AND COIL SPRINGS • DYNAMATIC DRIVES, BRAKES, DYNAMOMETERS

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the RIGHT Liquid Fuel Burner or Gas Burner for YOUR Job

The factory, salesrooms and general offices of National Airoil Burner Company, Incorporated, are housed in this modern daylight plant at "L" Street, Sedgley Avenue and Pennsylvania Railroad, in the great Northeast Industrial section of Philadelphia.

Whether you burn tar, oil, gas or a combination of these fuels, there's a NATIONAL AIROIL BURNER for your job.

Our more than 37 years' experience in the design, development and manufacture of all types of industrial burners is at your service.

Ask us about your requirements . . . we'll gladly give you full information.

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

TYPE "SA"

(For use where steam is available) *atomizes thoroughly* and *burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures.
Send for Bulletin No. 21.

TYPE "S-A-L"

(Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers.
Send for Bulletin No. 24.

TYPE "S-A-R"

(Where steam, or gas is available for atomizing) safely and efficiently burns residuums obtained from process.
Send for Bulletin No. 23.

COMBINATION GAS AND OIL BURNER

— the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner.
Send for "Airocool" Brochure.

"AIROCOOL" GAS BURNER

(Of venturi type), assures low turndown without burnback.
Send for "Airocool" Brochure.

MECHANICAL PRESSURE ATOMIZING OIL BURNERS

with multi-vane type air diffuser to give a positive swirl to entering combustion air.
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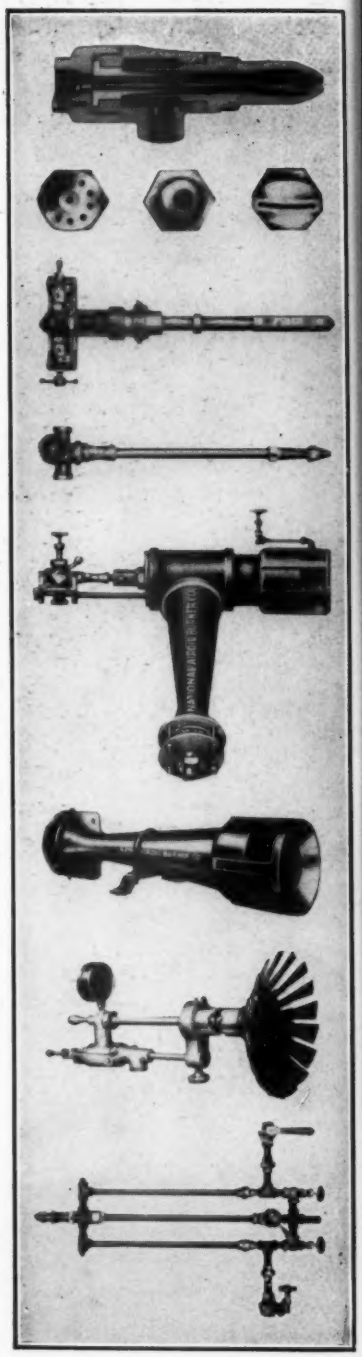
TYPE "S-A-D" (Refuse Oil Burner)

burns acids or caustic sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, tars, pitches, etc., in combination with fuel oil.
Send for Bulletin No. 21.



NATIONAL AIROIL BURNER CO., INC.

Main Offices & Factory: **1236 EAST SEDGLEY AVENUE, PHILADELPHIA 34, PA.**

Southwestern Division: 2512 South Boulevard, Houston 6, Texas

INDUSTRIAL OIL BURNERS, GAS BURNERS, FURNACE EQUIPMENT

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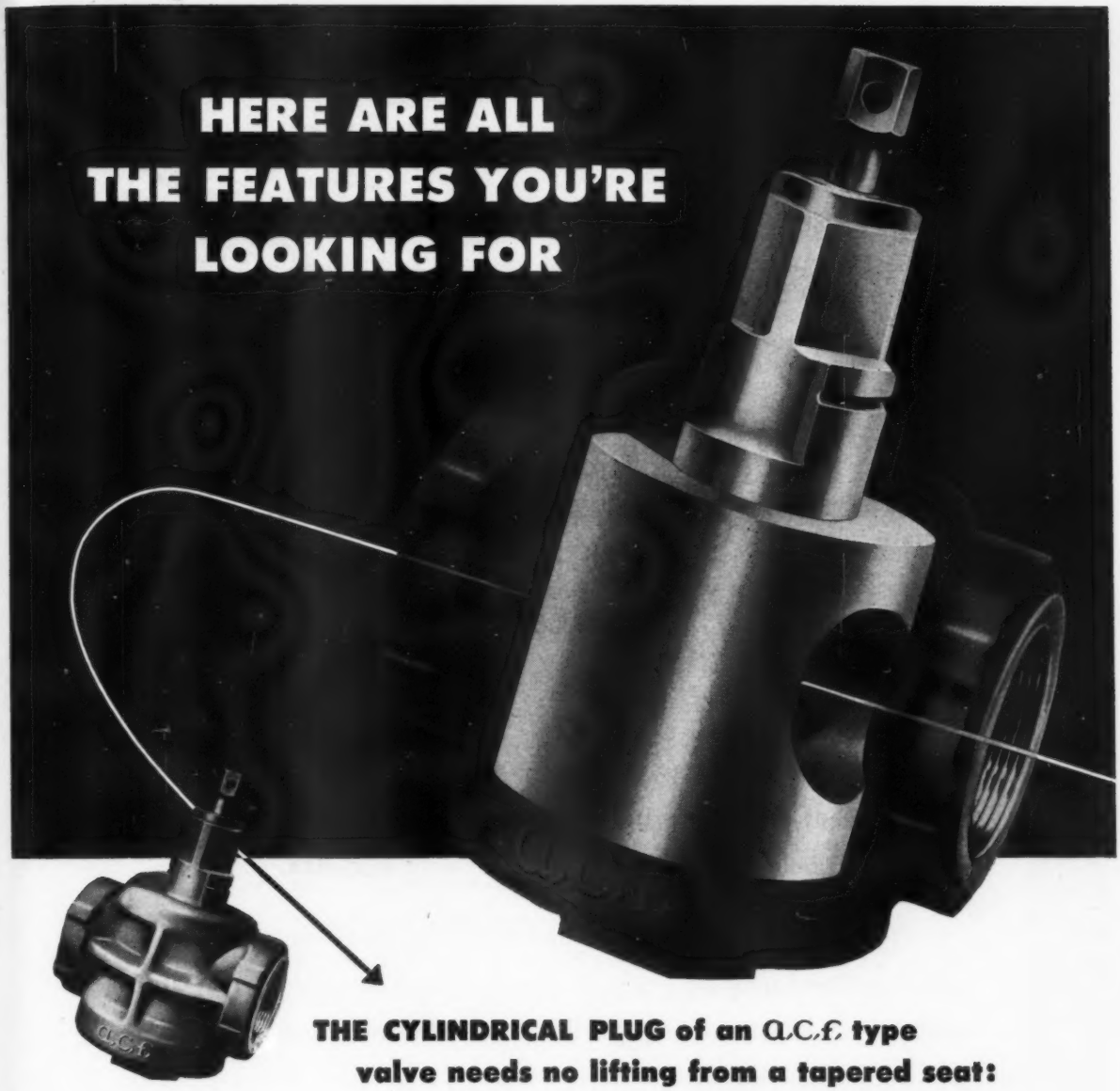
HERE ARE ALL THE FEATURES YOU'RE LOOKING FOR



THE CYLINDRICAL PLUG of an a.c.f. type valve needs no lifting from a tapered seat:

- Quick operation, if needed
- A quarter turn—full flow
- A quarter turn—full shut-off
- Straight-through flow—most desirable
- *Round* full pipe area port*—no restriction
- No exposed seats when on flow—no abrasion
- Lubricated—for long life and corrosion protection.

*Can be supplied in rectangular port with full area.

CYLINDRICAL FULL PIPE AREA LUBRICATED

a.c.f. PLUG VALVES

Representatives in more than 50 principal cities.

Write for catalog 4-OG describing types and sizes to: American Car and Foundry Company, Valve Division, 1501 Ferry Ave., East, Detroit, Mich.

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How much did CORROSION cost you last year...?

Any amount—large or small—was too much. You can protect every type of petroleum industry equipment, inside and out, above ground and below, even under water . . . with **RUST-BAN**.

Not a single product, **RUST-BAN** is a complete line of protective coatings developed by years of research and improvement—in oil fields, in refineries and on pipe lines. **RUST-BAN** prevents rust; it *inhibits* corrosion at the source.

Protect your equipment with **RUST-BAN**, the *complete* line of protective coatings for the petroleum industry.

ASK FOR RECOMMENDATIONS FOR YOUR JOB

Technical service engineers of any RUST-BAN distributor stand ready to serve you.

RUST-BAN

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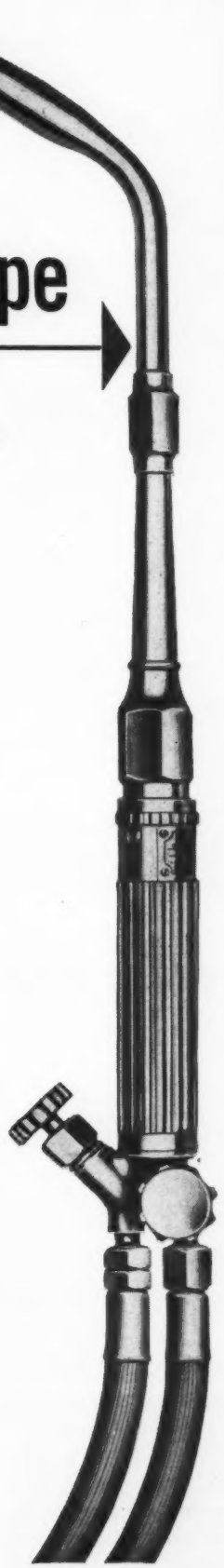
Standard Oil Company (Kentucky), Louisville, Ky.
Penola, Inc., Chicago, Ill.
The Carter Oil Company, Denver, Colo.
Esso Standard Oil Company, New York, N. Y.

With One OXWELD Blowpipe

Trade-Mark



You can do All these Jobs . . .

- √ **Weld steel (28 gage to 1 inch thick)**
- √ **Cut steel (up to 8 inches thick)**
- √ **Heavy-duty heating**
- √ **Braze-welding**
- √ **Hard-surfacing**
- √ **Gouging**
- √ **Rivet-cutting**

Whether you want to do one—or more than one—of these jobs, all you need is the OXWELD W-17 Blowpipe with the right welding head or a cutting attachment. You're assured high efficiency and economy because each size welding head has its own tip, mixer and injector to provide the correct flame for its range of metal thickness.

In addition to its adaptability for many uses, the time-proved design and sturdy construction of the W-17 assures dependable, long life. Added years of *trouble-free service* mean the greatest overall saving to you. Write or phone today for full information and a demonstration of this all-purpose blowpipe.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto

The term "Oxweld" is a registered trade-mark of Union Carbide and Carbon Corporation.

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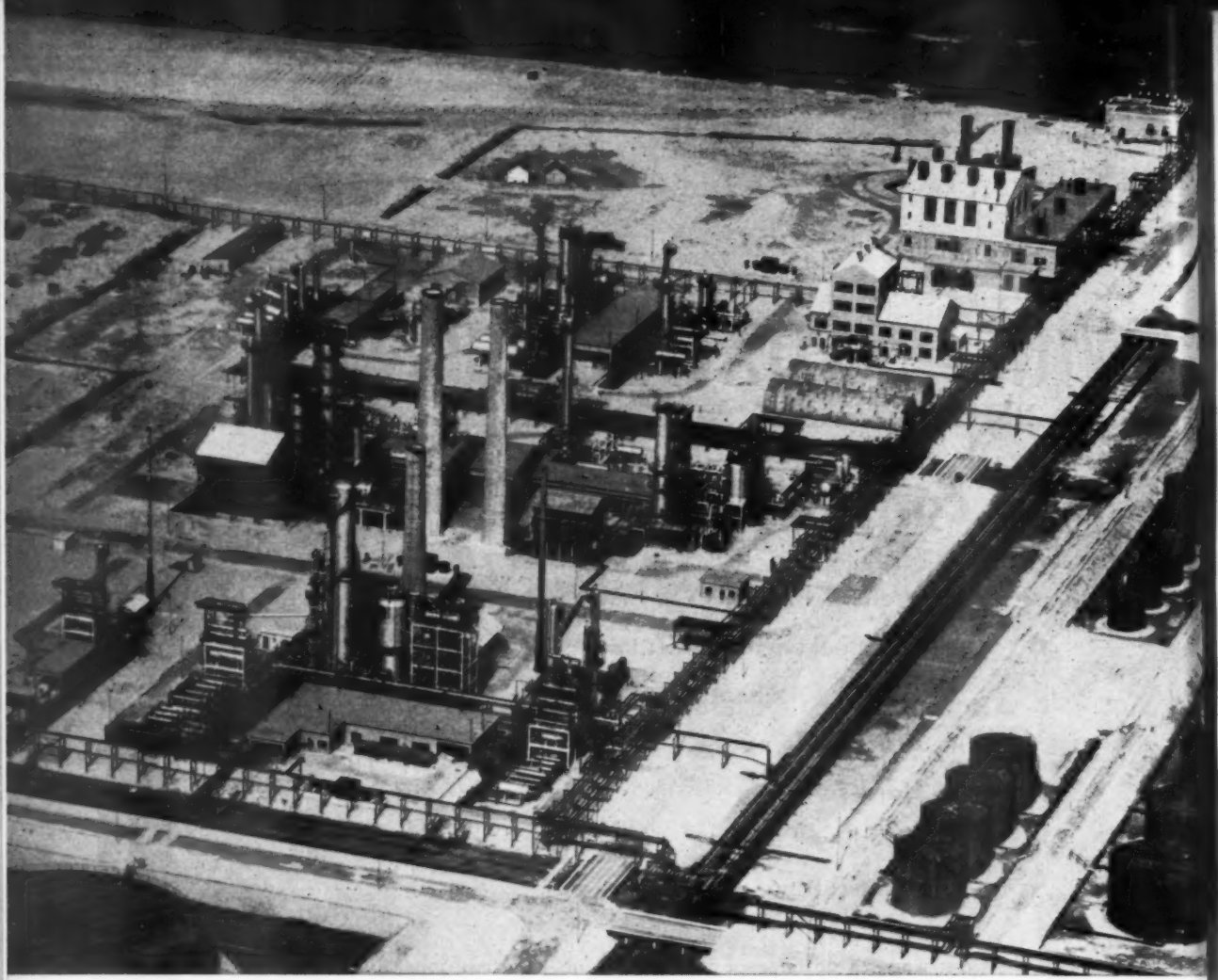


NEW 20,000 BARREL CALTEX HOLLAND REFINERY

Engineered and Constructed by

ARTHUR G. McKEE & COMPANY

This complete refinery, one of the most modern in Europe, is a typical example of the world-wide design, engineering and construction services provided by the McKee organization.

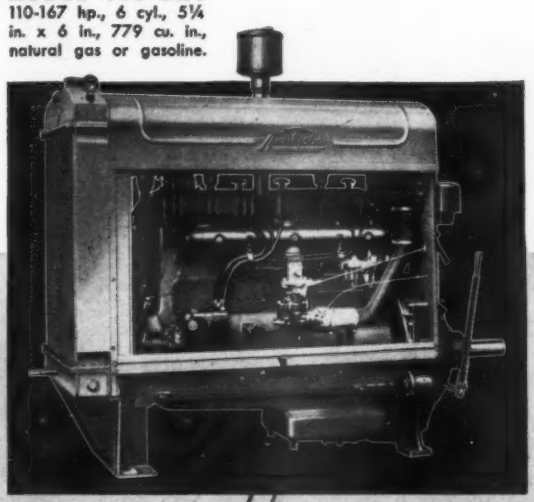
ARTHUR G. McKEE & COMPANY

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRI

ENGINEERS AND CONTRACTORS • ESTABLISHED 1905
2300 CHESTER AVENUE, CLEVELAND
30 Rockefeller Plaza, New York, N. Y.

"more than enough power at 5000 feet"

MODEL 145-GKU
110-167 hp., 6 cyl., 5¼ in. x 6 in., 779 cu. in., natural gas or gasoline.

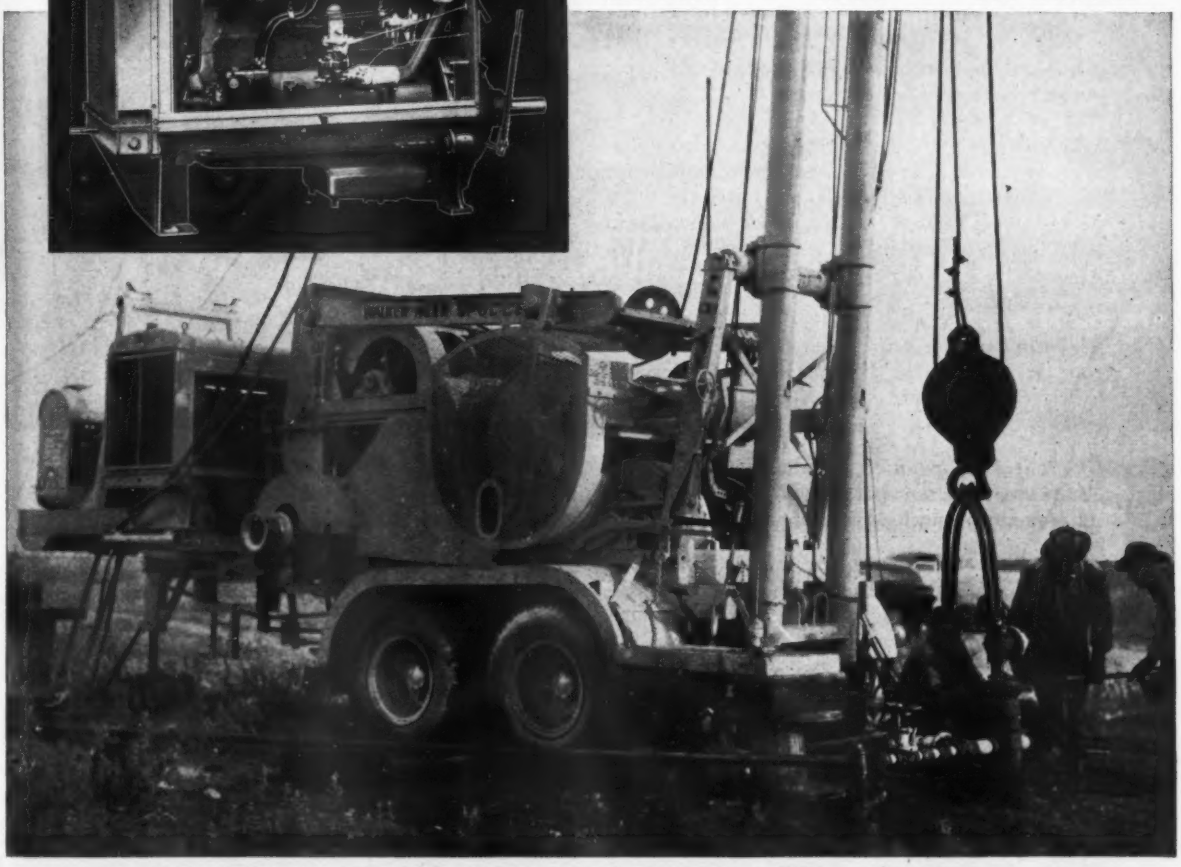


Deck Coleman of Texas Pacific Coal and Oil Co. says WAUKESHA-POWERED Walker-Neer Spudder does "a fine job" deepening well to below 5000 feet

"One of the most complete drilling units that I have ever worked with, around, or on," says Mr. Deck Coleman. It's a Walker-Neer Spudder with a Waukesha Model 145-GKU Power Unit. And "having been a driller at one time," District Superintendent Coleman knows his rigs *and* oil field engines.

"The rig-up time is cut in half and rig-down time never takes over one and one-half hours. The unit was used in this district (Sundown, Texas) to deepen a well to below 5000 ft. All drilling was done with a hole full of oil and using no water to drill with.... Clutches and brakes are a great improvement over any rig or unit I have ever run.... All work on this well was done in second and third gears. There is more than enough power for this unit at 5000 ft." Last report on this unit from Odessa, Texas—"doing a fine job cleaning out and drilling deeper." *Get Bulletin 1225.*

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES



WAUKESHA
OIL FIELD POWER

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pay off with ALCO AIRCOOLERS

Pioneered by one of the largest makers of heat exchangers, Alco **Aircoolers** are built to do just one thing and do it right—cool efficiently. To accomplish this, Alco engineers have built into every Alco **Aircooler** design features that give you *all* five of these major advantages:

1 ***Low Cost***—goes way beyond first cost. Alco standardized parts . . . broad heat-transfer experience . . . volume production . . . plus correctly engineered safety factors . . . insure *real* economies in installation, operation and maintenance of Alco **Aircoolers.**

2 ***Flexible Design***—You can get either the radiator core or fintube type cooler from Alco, powered by electricity, steam, gas or oil.

3 ***Efficient Performance*** — Induced draft design eliminates the chance of recycling hot air with a subsequent loss in heat transfer.

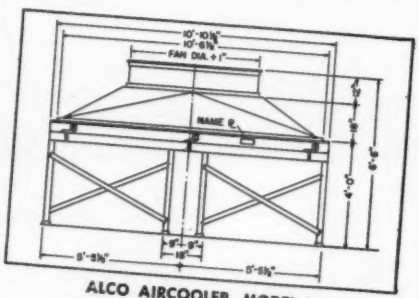
4 ***Easy Maintenance***—Fewer parts, easy accessibility and better wearing characteristics make Alco **Aircoolers** a favorite with maintenance men.

5 ***Quick Installation***—For fast field assembly, every part is marked and identified on assembly drawings so that no specialized labor is required.

Why not put the big 5 to work in your plant? Send for the free catalog on Alco **Aircoolers** *or call your nearest Alco Sales Engineer at Chicago, Cleveland, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants at Dunkirk, N. Y. and Beaumont, Texas.*

ONE AIRCOOLER FROM THE ALCO LINE

Hundreds of Alco Aircoolers are in service cooling jacket-water, gas, engine-lube oils, vapors, etc.



ALCO AIRCOOLER, MODEL I
CONDENSED SPECIFICATIONS

No. radiators—Four 6-ft. nominal length.

Fans—5 or 6 ft. dia.—2, 4 or 6 blade—adjustable or fixed pitch.

Drive—Direct, Electric Motor (V-belt or Gear Drive can be furnished on request).

Surface External — 2,720 sq. ft. Style T-5 (Water Core)—2,611 sq. ft. Style T-1 (Oil Core).

Surface Internal—450 sq. ft. Style T-5—347 sq. ft. Style T-1.

Face Area—46.4 sq. ft.

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AMERICAN LOCOMOTIVE COMPANY

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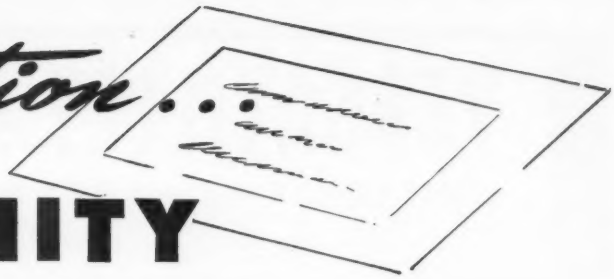

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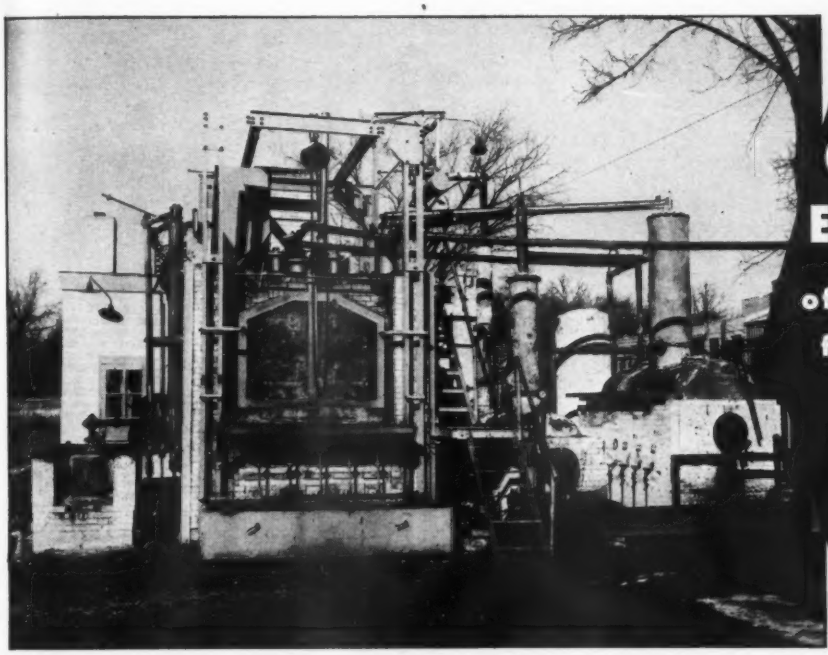

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They Say—

No Planning, Please

"With scientific ability or random luck, the varied concepts of many minds have been free to be applied to the search for oil, and much oil has been found.

"In other nations where the search for oil has been centralized, particularly under governmental control, the attempts have been far from successful. Under any centralization, there is a tendency for decisions to be made by a few people, often by only one.

"A single mind, regardless of its capacity, could not find the oil needed by this nation. Even the petroleum industry's most outstanding geologist or wildcatter would fail miserably if confronted with the task of mobilizing the entire search for oil for the nation.

"The planners and the controllers have always pointed to some of the outstanding errors that have occurred under private enterprise as evidence of the inefficiency of our system. Yet, who could say that centralized authority would have avoided these errors? And, are these errors anywhere near as great as the fundamental error of a controlled economy which inevitably suffers from the occupational disease of all bureaucracy—the fear of being wrong? This is the disease which leads men to do nothing rather than fail."

W. B. Emory, manager of production, Ohio Oil Co., speaking in Cody, Wyo.

Calling a Spade

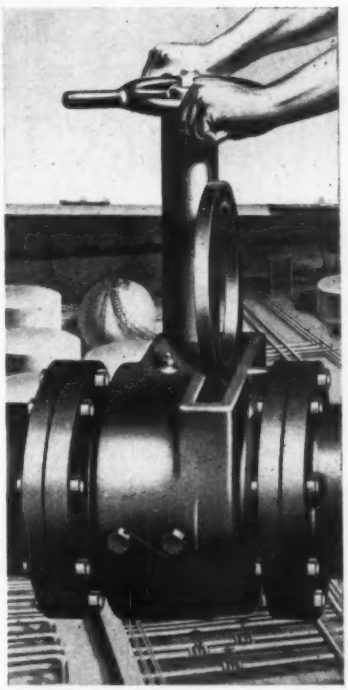
The editorial in the June 22 issue of The Oil and Gas Journal entitled "Calling a Spade" has brought comments from readers. The editorial commended the oil industry's leaders who have issued strong denials to reckless charges of the Department of Justice and to Washington investigators. It was pointed out that these charges in many instances were made to promote political aims. Following is the comment of a vice president and general counsel of one of the larger oil companies:

"I have read the editorial entitled "Calling a Spade—" on page 145 of your June 22 issue.

"Unfortunately, the editorial writer is absolutely right. I say 'unfortunately' because the editorial demonstrates how far our entire legal system has disintegrated in recent years.

"The traditional concept of the common law is that it consists of a set of rules established by precedent. While flexible enough to cope with changing conditions, those rules are supposed to stand as guides to permissible

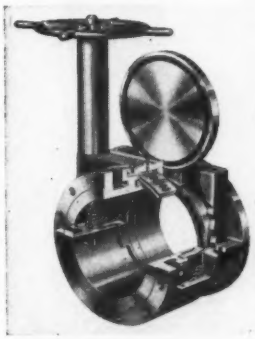
NOW BLIND RIGID LINES
in the COST-CUTTING
HAMER
hand wheel
operated way



When Hamer Line Blind Valves were introduced years ago, the old expensive and hazardous way of blinding pipe lines with a spectacle bolted between companion flanges became obsolete. The Hamer family of positive, one-man operated line blinding units has now grown until there is *a Hamer Line Blind Valve for every application*—EVEN FOR BLINDING RIGID LINES where no endwise movement is possible.

The new "RIGID" Line Blind Valve solves the problem of blinding inflexible lines in refineries, process plants, tankers and other ships...wherever rigid piping installations must be opened and closed. *It's speedy and cost-cutting*—one man can reverse the plate in one minute. It's *safe*—enclosed plate slot prevents spilling line fluid. *It's positive*—there's nothing like a solid plate for a permanent, leak-proof shut-off.

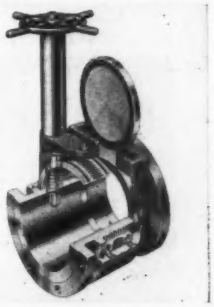
Positive shut-off without pipe line movement!



Actuated by the hand wheel, a smooth-turning ball bearing mounted ring gear moves the sliding internal sleeve in a straight line to clamp and release the plate, eliminating the need for spreading the line. "RIGID" Line Blind Valves conform to A. S. A. Standards for face-to-face dimensions of steel wedge gate valves. In planning new layouts, or modernizing existing installations, use a gate valve for blocking but specify Hamer "RIGID" Line Blind Valves at every point where quick, one-man operated, POSITIVE SHUT-OFF will be required.

LEFT—"RIGID" LINE BLIND VALVE

RIGHT—SPOOL-TYPE LINE BLIND VALVE



SPEED, ECONOMY, SAFETY IN BLINDING FLEXIBLE LINES!

There are Hamer Line Blind Valves for every blinding application. All models feature cost-cutting "one-man, one-minute" operation, positive shut-off, and long service life. Write for full information.

Illustrated below are: 1—Spool-Type, side hand wheel. 2—Spool-Type, upright hand wheel. 3—"Tee" and "Ell" Type. 4—Economy 3-Bolt Type.

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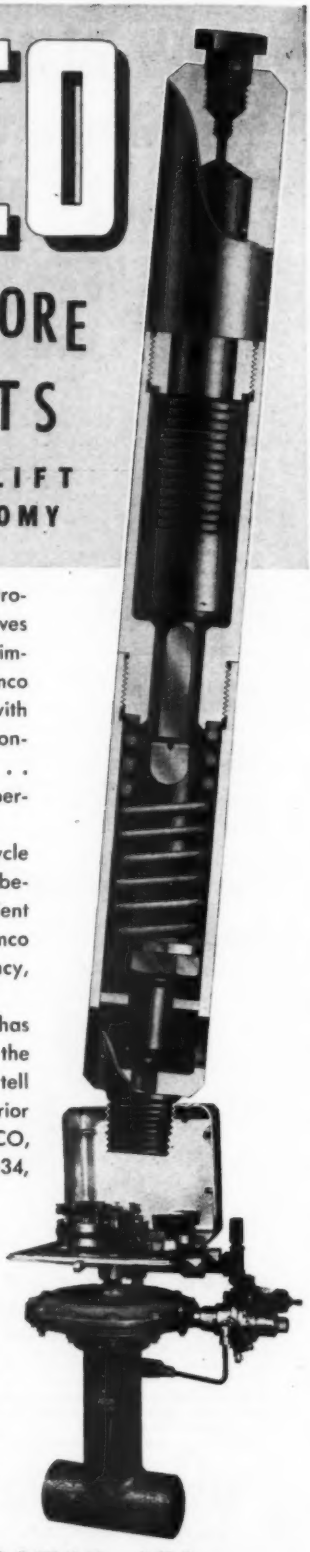
TO INCREASE GAS LIFT EFFICIENCY AND ECONOMY



When Camco Gas Lift Valves were introduced to the oil industry, we pledged ourselves to a program of continuous research and improvement. Camcoizing . . . an exclusive Camco process which pre-forms the valve bellows with 5000 lbs. differential pressure to test and condition the bellows for positive well action . . . was the original basis for the superior performance of Camco Valves.

Now Camco has developed a new Time Cycle Surface Controller Unit (right) which we believe is the finest, simplest and most efficient motor valve yet produced. The new Camco Motor Valve is designed for strength, efficiency, endurance and snappy action.

For nearly four years, Camco equipment has been in the most demanding services in the field. Write for details. We would like to tell you the complete story behind the superior performance of Camco Equipment. CAMCO, INC., 7317 Canal Street, P. O. Box 9334, Central Park Station, Houston 11, Texas.

CAMCO'S NEWEST SUCCESS

Camco now has a new dual completion mandrel, bottom hole packoff and tubing hanger which makes it easy and efficient to lift fluid from two zones through concentric strings of tubing using casing for gas energy. The first one was installed February 20, 1950. Write for complete engineering details.

CAMCO

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CAMCO *Leads* IN THE GAS LIFT FIELD

and lawful conduct in the future. In other words, the common law system is one of principles, not merely the passing whims or predilections of a few men dressed in black robes.

"In certain fields of the law involving social and economic problems—such as are involved in respect of monopolies, restraints of trade, and fair business practices—our present federal law-enforcement officials, as well as judges, have abandoned the traditional concept. Instead, they embrace the theory that we ought to be governed by what, for the time being, they deem to be socially most desirable and politically most expedient. Indeed, implicit belief in this theory seems to be a prime requisite for appointment to the position of Attorney General or Supreme Court Justice.

"Having forsaken the solid rock of time-tested legal principles, these men are forced to build on the shifting sands of current opinion and political pressure. They feel constrained to please the greatest number of voters, rather than to apply and administer the law as it is written in the statute books and as it has been handed down by prior generations of judges. No wonder, then, that these Fair Dealists find it necessary to test out public opinion to ascertain what actions they ought to institute and, once started, how such actions should be decided. So, when they find public opinion on the subject either undeveloped or contrary to their own slant, they endeavor to shape public opinion and channel it in the desired direction. It is, I think, largely for these reasons that we now find the Department of Justice trying each new antitrust case in the press long before it ever comes up for trial in court.

"For these same reasons, American business and industry can no longer sit back and await a just decision at the trial. Such tactics will lose the case in court. In short, we have come to the point, apparently, where antitrust litigation must be won in the court of public opinion before it can be won in a court of law.

"I deplore this situation, as do all lawyers who once thought they could advise their clients on the basis of precedents found in law books. But inasmuch as those happy days are gone—for the time being, at least—we now can only say to our clients: 'Get the voters on your side; obtain the support of pressure groups; have the C.I.O. Political Action Committee speak a word in your behalf. If you do these things, your case is in the bag!' "

Imports and War

"We now have a hot war on our hands which I believe has taken most of the steam out of the foreign-oil controversy for the perfectly clear and simple reason that if another world war results from the Korean

situation, this country will need oil from every possible source. . . .

"In these troublesome times it is well to remember that before the last war was won, 35 per cent of the Allied military and naval petroleum requirements were being met from foreign sources.

"In the event of any threat to world peace, we would need our own high-gravity crudes particularly for such special products as aviation and jet fuels. We would need the marginal crudes from sources outside the United States to fuel ships for other vital purposes."

Cecil Morgan, vice president, Esso Standard Oil Co., speaking in New Orleans.

No Compromise

"If we accept a (tidelands) compromise, how could we ever convince Congress or any other state that we ever owned the lands in the first place? There should never be a compromise. Whatever they get, let it be over our resistance and without our consent."

Price Daniel, Texas attorney general, speaking in Austin.

Background of Success

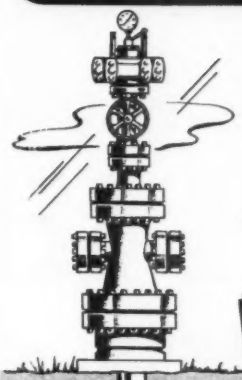
"Whether the petroleum industry is the golden egg laid by the chicken of our prosperity, or the chicken itself, there can be little doubt that the economic success of the country is the result of a favorable political and social climate combined with the determination and resourcefulness of its citizens.

"With respect to the petroleum industry, there can be little doubt that its early and continuing growth in this country is founded on the private ownership of land, including minerals beneath the surface, the right of these owners to make contracts for mineral exploration and development with whomever they chose, and the right of other individuals, either alone or in groups, to speculate in petroleum exploration with resources which they had accumulated.

"Although probably wasteful, the early unrestricted production of oil permitted the rapid return of speculative capital and provided important accumulation of capital with which to undertake similar exploration elsewhere. These rights of free choice of free men to make such arrangements as they might desire with respect to their own property are undoubtedly the fundamental difference between those 'have-not' countries with their great petroleum resources and our country with its great petroleum production and prosperity. The failure of governments in business is universal, and is particularly noteworthy in the oil-producing business."

Gail F. Moulton, second vice president, Chase National Bank, speaking in Cody, Wyo.

ANOTHER TUBE-KOTE STORY



EAST TEXAS SALT WATER INPUT STRING

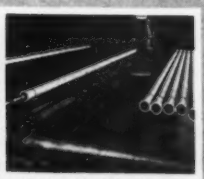
*TUBE-KOTED IN DECEMBER, 1944

. . . HAS BEEN IN USE CONTINUOUSLY WITHOUT SHUTDOWN FOR 5½ YEARS!

13,000 barrels of corrosive salt water has been injected daily into this "Tube-Koted" 7" input string, since it was installed in December, 1944. Engineers on this installation say that the original cost of "Tube-Koting" this string was recovered during the first three years of operation through savings effected by avoiding the usual costly shut-downs and replacements.

FIGHTING CORROSION BY PROTECTING THE SURFACE WITH THE TUBE-KOTE PLANT-CONTROLLED PROCESS

THOROUGH CLEANING OF EVERY JOINT



SAND BLASTING TO BASE METAL

AUTOMATIC COATING

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All of these steps plus rigid inspection between each operation assure highest quality workmanship.

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TUBE-KOTE

First Name In Corrosion Resistance

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TRIPLE SEAL

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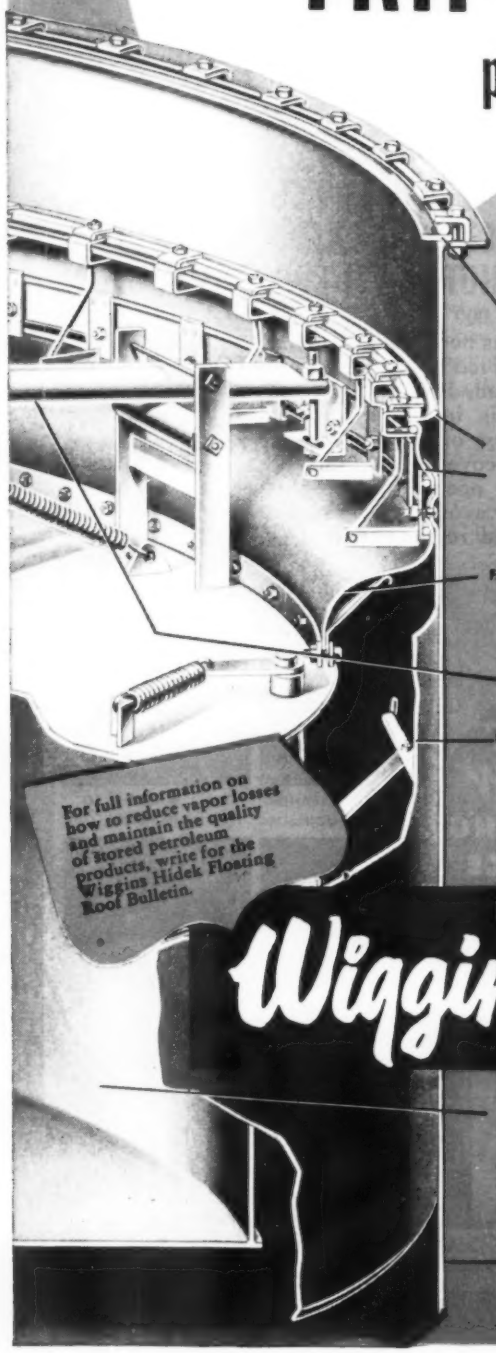

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JOURNALLY Speaking

And So to Bed

NOW that this issue has "gone to bed," as we say, John Casper, our staff economist, is going to bed himself. John says it will take two solid weeks of concentrated loafing to get rested up from the many weeks of planning, polishing, and putting together the economics and statistical part of this Midyear Report.

We asked John to figure up how many man-hours went into the compilations, but he was too punch-drunk to give his adding machine one more poke, so he just mumbled "plenty," and kept on staring blankly at the press proof of the drilling forecast.

"They're going to drill a lot of wells," he muttered. "More than most people figured. I reckon it'll be something of a surprise to a lot of folks."

To prepare this surprise took many weeks of work by many members of our staff. The drilling forecast is based on questionnaires sent to all operators, and checking and tabulating these was a job in itself. Compiling the record for the first half of the year was a separate job, involving "keeping books" on the entire oil industry every week. But this midyear drilling report and forecast is an exclusive Journal feature, the only one of its kind, and the value to the industry is worth all the labor.

There are a lot of other statistical reviews and economic forecasts in this special issue, information of real, timely value to every branch of the industry. And to top it off there is our Midyear Engineering Reference Section, which has come to be a widely anticipated and used part of this yearly special.

Fancy Figures

OIL men in the United States habitually think of oil production and refining in terms of barrels per day. Europeans deal in tons per month or year, but here everything is reduced to a daily basis.

Everything, that is, except drilling wells. For some reason or other we never heard anything about the daily rate of well completions. We were struck by this anomaly while perusing the proofs of the special statistical section in this issue. So we asked our statistical department to start up the calculating machine and figure it out.

During the first 6 months of this year, the figures showed, the American drilling industry completed 111.9 wells per day. (That nine-tenths well, probably, was where they had to shut down in the evening and come back to finish it the next morning). The forecast for the rest of the year of 124.1 wells per day.

That's quite a group of wells for one day. Most people don't realize how much drilling activity is going on because it's spread all over the landscape. If wells were produced in a factory, and all under one roof, the plant would be one of marvels of the industrial age and would attract more awe than the Chicago stockyards or the Detroit automobile plants. Imagine, if you can, an assembly line turning out thousands of feet of hole per minute for shipment to oil fields all over the country.

If our statistical crew hadn't been so fagged out from completing this special issue we would have asked them to figure out the number of feet of hole drilled every minute in this country. But you can figure it yourself from the material in this issue. You can also use this material to obtain a lot more useful figures, figures which any oil operator can use in planning his own business.

Wearin' o' the Green

THE green ink used on the first 24 pages of the special section does not reflect Irish ancestory in our staff nor does it indicate that we are freshmen and green at the business of reporting and forecasting the oil industry's activity.

It's just a little idea of our art director to set off the very special nature of the material on these pages. He couldn't use red ink because the industry certainly isn't in the red. Green is the color of growing things, so what could be more appropriate?

—Henry D. Ralph

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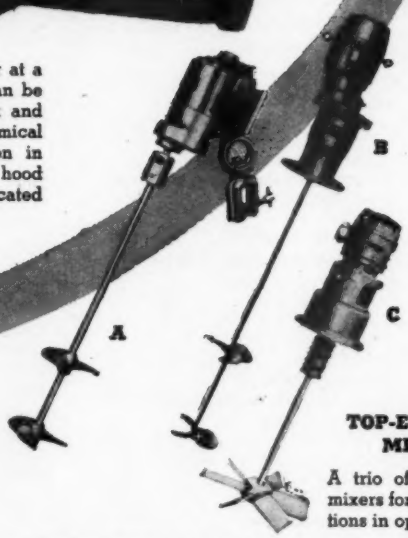

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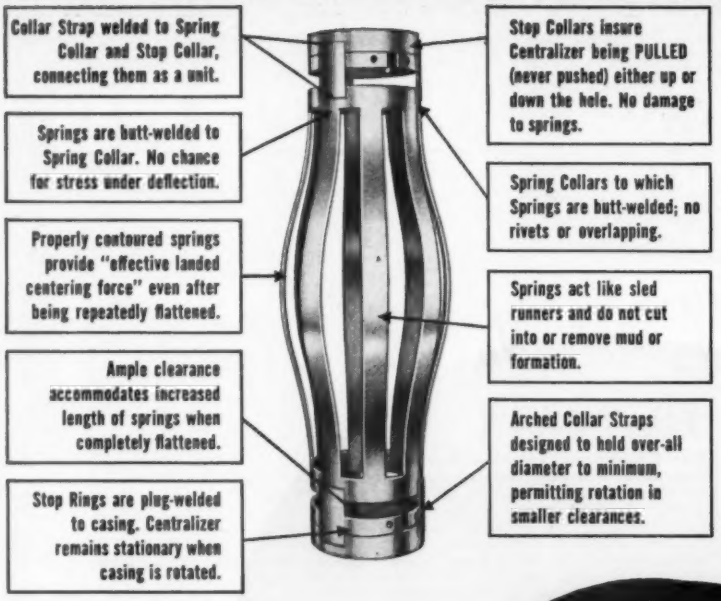
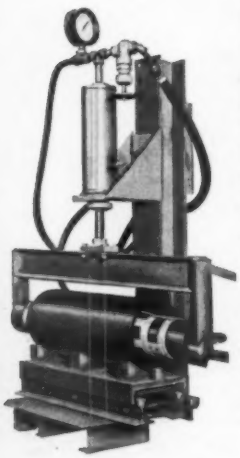

Collar Strap welded to Spring Collar and Stop Collar, connecting them as a unit.
Springs are butt-welded to Spring Collar. No chance for stress under deflection.
Properly contoured springs provide "effective landed centering force" even after being repeatedly flattened.
Ample clearance accommodates increased length of springs when completely flattened.
Stop Rings are plug-welded to casing. Centralizer remains stationary when casing is rotated.
Stop Collars insure Centralizer being PULLED (never pushed) either up or down the hole. No damage to springs.
Spring Collars to which Springs are butt-welded; no rivets or overlapping.
Springs act like sled runners and do not cut into or remove mud or formation.
Arched Collar Straps designed to hold over-all diameter to minimum, permitting rotation in smaller clearances.

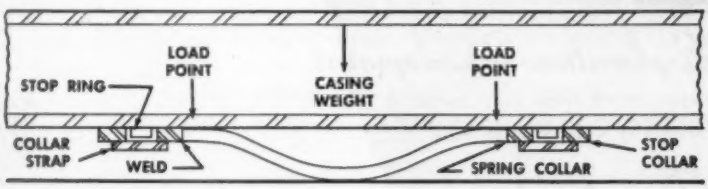
EASY STARTING WITHOUT "SNUBBING"

Testing to determine the maximum number of springs, of optimum bowed height and length, to insure easy starting, particularly of the first few joints when there is no accumulated weight. Minimum interval spacing of Baker Model "G" Casing Centralizers also was determined with this testing equipment.



With this testing device it is possible not only to simulate rugged downhole travel by repeatedly flattening the springs, but also to find the effective centering force of the centralizer in the open hole, after such treatment. The maximum centering force is easily determined from a performance curve showing the centering force at various intervals of deflection.

Operators who know ALL the facts about the Baker Model "G" Casing Centralizer specify and run them exclusively. They know from experience that they are buying the greatest possible centering force for their casing, to be applied *exactly where they want it in the hole.* Isn't that what you too expect and really want from a casing centralizer?



Here is the ideal in spring design and mounting, found only in the Baker Model "G" Casing Centralizer. Note how the load point is imposed directly upon the casing; and how the properly "contoured" spring is free to move along the smooth surface of the casing as it deflects under compression. There is no chance for concentration of stress to cause a permanent set, or to result in breaking of the spring. Note that ample clearance exists between Stop Rings and Spring Collars to accommodate the increased length of the springs which results from their complete flattening.

Additional interesting facts and illustrations are contained in a new 16-page brochure which proves conclusively that no other spring-type centralizer even approaches the EFFECTIVE LANDED CENTERING FORCE afforded by the Baker Model "G" Casing Centralizer. Ask for your copy today from any Baker office or representative.

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Taking Stock

The Journal's Midyear Report on the status of the petroleum industry is particularly timely this week when the entire nation is taking stock of our economic potential to conduct police actions in many parts of the world and possibly to wage a prolonged war.

The statistics in this issue were compiled before the President called on Congress for partial industrial mobilization. Therefore the forecasts for the last half of the year do not take into consideration any military demands for petroleum products nor any governmental interference with the industry's supplies, manpower, or planning.

The report shows the industry operating at the highest levels in history and headed for new peaks. Crude production has been climbing rapidly from its relative slump of last summer and seems headed for the all-time high point of 2 years ago. Demand is forecast at more than 6 per cent above last year, and in anticipation producers are planning the most active drilling campaign ever and refiners are preparing for new record runs. Construction of new pipe lines, refineries, and other facilities is planned to keep pace and anticipate further increases in activity.

This would suggest that the petroleum industry is well prepared for any emergency which may be imposed on it by the international situation. This is probably true as a short-range proposition. Unquestionably oil as an industry is better prepared than some others.

But this should not lull Washington planners into a false sense of security. The industry has a little slack, but this would disappear rapidly if a war economy should take a large chunk of its products and particularly if supplies for continued expansion are not available. To expand capacity to produce, refine, and transport requiries tremendous amounts of supplies and equipment. If its materials are diverted to other uses, the oil industry will not be able to keep its promises of growth.

Taking stock of the industry in the light of happenings of recent weeks leads to the conclusion that oil can meet any demands the Government is likely to make of it during the balance of this year. The presently contemplated scale of mobilization and military action should not require a heavy drain on the supply of petroleum products.

The potential threat to the industry's steel supplies is somewhat more serious. Steel was already tight, and the rush to place advance orders has thrown the steel market into a temporary frenzy. But there is every reason to believe that a semblance of order will be restored soon and it will be discovered that defense orders will not require the diversion of tremendous tonnages for at least several months.

For the rest of 1950 the oil industry can look forward to continued high rates of activity and expansion. Beyond that the outlook depends on international developments and the wisdom of our statesmen.

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THIS WEEK

DEFENSE—Planning for a war economy preoccupies government and industry. . . . Congress starts work on mobilization plans, partial control of materials, bigger military appropriations, higher taxes. . . . Administrative agencies recast their programs for possible condition of prolonged near-war. . . . Rumors and jitters are rife but definite program for oil industry has not yet jelled. . . .

STEEL—Fear of steel shortage shakes oil and other industries. . . . Rush of advance orders causes mills to close books pending government allocation plan. . . . I.P.A.A. moves to insure steel for producers. . . . ¶Prospect is for allocation of basic steel only at the start and not much diversion to military uses for several months. . . . Increasing tightness next winter may hamper oil-industry construction plans. . . .

INDUSTRY—National Petroleum Council meets to exchange views with government officials on planning for possible war measures. . . . Lessons of early World War II confusion recalled. . . . ¶Future planning being recast in light of possible heavy increase in demands, shortages of supplies, and military requirements for special products and transportation. . . . ¶Octane race definitely halted by prospect of increase in aviation fuel.

OUTLOOK—Oil and gas industry headed for new high levels of activity in all branches even before Korean war broke. . . . Increased industrial tempo caused by preparedness program may raise demands above present forecasts. . . . ¶Direct military requirements for petroleum products not expected to be a drain on supplies for several months, but there will be a step-up in special products. . . .

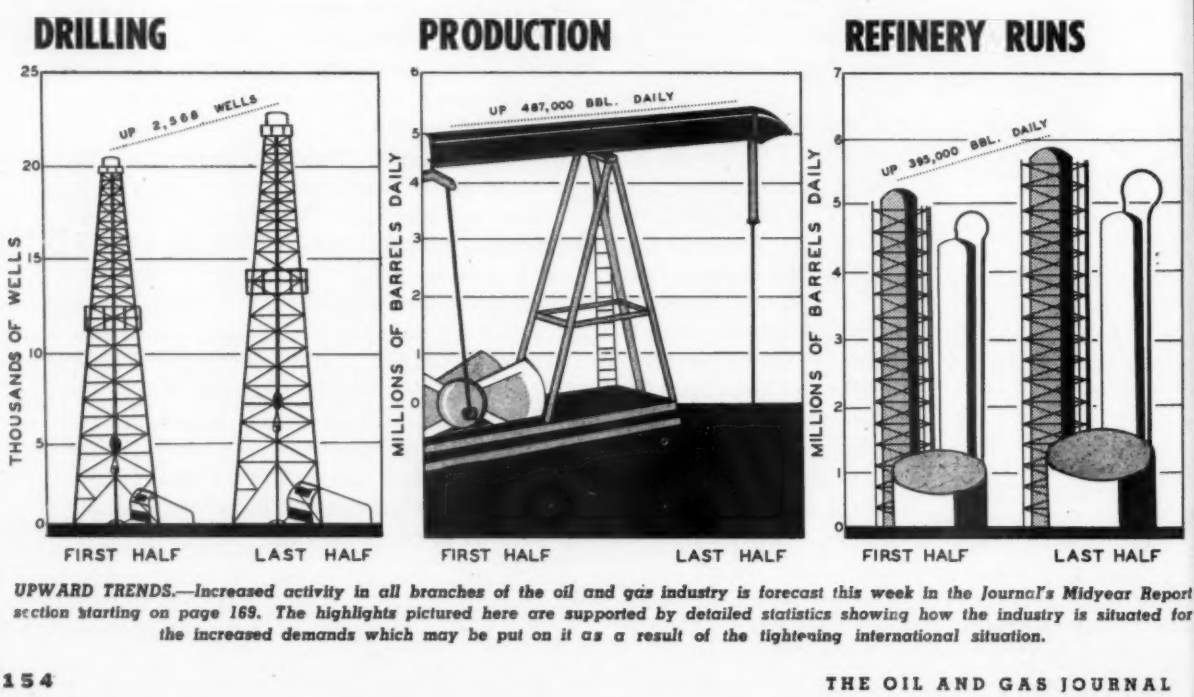
ACTIVITY—Crude production for week ended July 22 averaged 5,455,725 bbl. daily, an increase of 52,300 bbl. daily over previous week. . . . ¶Well completions totaled 917 for the week compared with 821 for previous week and 729 for same week last year. . . . Wildcat completions increased 13 wells over previous week to 178. . . . ¶A total of 2,167 rotary rigs were operating in United States on July 17 compared with 1,955 last year. . . .

TRENDS—Refinery runs for 3-week period ended July 15 averaged 5,857,000 bbl. daily or 666,000 bbl. daily more than in same weeks last year. . . . ¶Major product stocks, abnormally low at the beginning of summer, increased 244,000 bbl. daily faster than last year. . . . Demand for products from refineries averaged about 400,000 bbl. daily more than last summer. . . .

INTERNATIONAL—World crude output reached all-time high in May. . . . 9,842,000 bbl. daily. . . . Middle East showed big jump. . . . Venezuela was down because of strike but has since headed upward. . . . ¶Pemex makes drilling contracts with two additional U. S. operators for Mexican exploration. . . . ¶New German refinery started to handle indigenous crude. . . .

PIPE LINES—Miami Valley Corp., jointly owned by Pure and Sohio, will build 58-mile products line between Dayton and Cincinnati. . . . ¶Sun Oil's Susquehanna system will build 125-mile, 8-in. products line from Toledo to Sarnia, Ont. . . . ¶FPC authorizes construction to nearly double capacity of Michigan-Wisconsin Pipe Line Co. gas line from Texas to Detroit. . . .

REFINING—Modernization of Deep Rock's Cushing refinery nearly complete as new catalytic cracker goes on stream. . . . ¶North Dakota and California independents discuss construction of 2,000-bbl. refinery at Grand Forks, N. D. . . . ¶Sunray will rebuild and modernize its refinery at Santa Maria, Calif., partially destroyed by fire. . . . McMurrey Refining Co. modernizing its Tyler refinery. . . . ¶Pennzoil negotiating to buy Pittsburgh refinery of Waverly Oil Works. . . .



UPWARD TRENDS.—Increased activity in all branches of the oil and gas industry is forecast this week in the Journal's Midyear Report section starting on page 169. The highlights pictured here are supported by detailed statistics showing how the industry is situated for the increased demands which may be put on it as a result of the tightening international situation.

War Hits the Industry

Allocation of steel under war economy may kill plans for some pipe lines; black market already reported developing

Bertram F. Linz

WASHINGTON.—A scramble for steel appears to be the first big problem facing the oil industry as the administration moves toward partial military and industrial mobilization.

The first inklings that the situation in Korea might lead to a war economy if not a full-scale war caused a flood of orders on steel mills from virtually all industries needing this commodity. For example, the backers of several pipe-line projects which are still in the preliminary planning stages attempted to play safe by placing orders for pipe for delivery some time next year.

As a result, the basic steel producers last week voluntarily stopped taking any orders for the first quarter of 1951. They will attempt to fill all orders now on the books, even where deliveries are scheduled to extend beyond the end of this year, but are making no definite promises.

This is admittedly a stop-gap measure on the part of the steel industry to keep the situation from getting out of hand. A black market in steel already is developing, and some purchasers are acting almost hysterically.

Controls expected.—Within a few days it is expected that the administration will have some sort of official plan for dealing with the steel situation. Probably a voluntary allocation plan under government sanction will be put into effect until legislation can be enacted.

President Truman has asked Congress for legislation giving the administration authority to impose priorities and allocations of materials, to requisition materials and facilities, and to control credit and commodity speculation.

The requested authority to allocate materials expressly prohibits the rationing of consumer goods at the retail level, although it naturally will reduce supplies available for the manufacture of such goods. The President indicated he has no intention of asking for rationing and price-control authority unless inflation makes governmental controls necessary.

The general belief is that, for the time being at least, allocation of materials will be used only to assure supplies for filling direct military orders. However, if this results in severe shortages of steel and other basic commodities it is very likely that there will be pressure for priorities to aid in the expansion of essential industries, such as oil.

Industry aid seen.—Under the new Defense Production Act which Congress is considering, the Government will aid industry in the expansion of present plants and construction of new facilities by loans to be made by the Reconstruction Finance Corp. and new government agencies to be set up which will have authority to borrow up to $2,000,000,000 from the Treasury and will be responsible for procurement and loan programs.

The broad language used in the bill would permit the Government to aid financially in the construction of such new refineries or other facilities as may be required in the oil industry, and even to help in the construction of synthetic-liquid-fuels plants if necessary.

So far there has been no official suggestion that the Government may tell industry what projects to push and what to postpone, but there is speculation that this will be done if the country gets down to serious, long-range war planning. This could mean that the Government might order or request the construction of certain pipe lines deemed necessary for military reasons.

For example, if it appears that military demands for petroleum products on the West Coast will be particularly heavy it is possible that construction of a crude-oil pipe line may be asked from West Texas or from the Rocky Mountain area. On the other hand, certain projects now in the planning stage may have to be shelved if the Government feels that they are not sufficiently essential to warrant the allocation of steel.

Liquid fuels are specifically mentioned in a provision authorizing purchases or commitments to purchase raw materials for government use or for resale. Such arrangements may be made without regard to limitations of existing law, "for such quantities, and on such terms and conditions, including advance payments, and for such periods as the President deems necessary, except that purchases or commitments to purchase involving higher than currently prevailing market prices or anticipated loss on resale shall not be made unless it is determined that supply of the materials could not be effectively increased at lower prices or on terms more favorable to the Government, or that such purchases are necessary to assure the availability to the United States of overseas supplies."

Oil problem.—As the administration moved to put the country on a war basis two big problems faced the oil industry.

One was the very definite demand by some members of Congress for immediate all-out mobilization instead of the progressive-step method which the President apparently is adopting. If such control was adopted it would mean rationing, price and wage regulation, and other restrictions, some of which may not be necessary for a long time, if at all, before any real evaluation has been made of what may be needed.

The other big question for the industry was the form and policy of steel allocations, particularly with respect to oil-country goods which already are in short supply. Throughout the last war the industry complained continuously that it was kept in short supply and that too much was being sent abroad.

This problem already has been called directly to President Truman's attention in a letter sent him last week by Russell B. Brown, general counsel of the Independent Petroleum Association of America, warning that merely to maintain drilling at its present annual rate of about 140,000,000 ft. and to keep producing facilities for oil and gas in repair not less than 2,842,200 short tons of steel a year will be required.

"The ability of the petroleum industry to meet current and increasing oil requirements is dependent upon a continuous and aggressive program of exploration and development," Brown told the President.

To provide that, he continued, the industry must have adequate trained personnel, adequate funds, and a sufficient supply of materials. Unless a substantial level of exploration and development can be maintained, producing capacity at the present rate of production will decline by approximately 500,000 bbl. daily within 12 months.

Steel needs.—Brown tabulated the steel requirements of the industry to maintain operations at their present level, reporting that oil-country tubular goods will require 1,281,000 tons of carbon and 286,200 tons of alloy steel, line pipe will take 373,700 tons, of carbon and 33,800 tons of alloy steel, and other needs will require 866,700 tons, comprised of 219,200 tons of cold and hot-rolled bars, 200,200 tons of ingots and billets, 103,000 tons of plate, 136,500 tons of sheet and strip, 89,300 tons of castings, 96,200 tons of structural shapes, 1,700 tons of rails, 1,100 tons of tin plate, and 19,500 tons of wire rod and wire.

But, he added, these requirements

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cover the needs only for oil and gas exploration and development and repair and maintenance of producing facilities, and do not cover the requirements for natural-gasoline and pressure-maintenance plants, the extent of which can be determined only by a survey of plants and facilities now operating and to be built, nor the steel needed for oil transportation, refining, and distribution.

Brown pointed out that domestic crude production is approaching and probably will soon exceed 5,600,000 bbl. daily, and emergency or wartime needs may call for further increases. He recalled that in 1941, production averaged 3,840,000 bbl. daily which had to be increased by 27 per cent, or 1,050,000 bbl. per day, to the peak war level of 4,890,000 bbl. daily in June 1945.

Brown did not mention it in his letter, but recent studies have shown that the reserve capacity now is less, particularly in proportion to current operation, than when we entered the war in 1941, which means that an increase on the order of 27 per cent would mean a much greater expansion of activity and consequent need for materials.

"Any interruption or curtailment of these essential material supplies would have serious adverse effects upon oil-producing capacity in the United States," Brown concluded.

In a further step to insure oil producers a supply of steel and equipment, the I.P.A.A. this week created an Oil and Gas Field Materials Committee, headed by Bryan W. Payne, independent oil operator of Tyler, Tex. The first duty of this committee probably will be to make sure that in any allocation of basic steel there is assurance that sufficient supplies will be given to pipe mills and other manufacturers of drilling and producing equipment.

Tidelands Safeguard

Protection for existing leases is provided in Senate resolution; procedure for granting new leases included

WASHINGTON. — Legislation providing for operation of the oil reserves of the tidelands and Continental Shelf pending final settlement of the issue of ownership was introduced in Congress last week by Sen. Joseph C. O'Mahoney of Wyoming to prevent possible interruption of development.

Under a resolution prepared by O'Mahoney, all existing leases in the marginal seas off California, Texas and Louisiana issued prior to December 21, 1948, the date on which the Texas and Louisiana cases were filed, or made subsequent thereto with the approval of the Secretary of the Interior, would remain in full force and effect, and all funds paid by lessees would be deposited in a special fund in the Treasury pending the enactment of legislation by Congress concerning their disposition.

In addition, the secretary would be empowered to grant leases over a period of 3 years on submerged lands not now leased. The leases would run for a period of 5 years and as long thereafter as oil or gas may be produced in paying quantities on a royalty of 12½ per cent and would be granted to persons offering the highest bonuses in competitive bidding. Funds derived from such operations also would go into a special fund.

The resolution provides that the secretary, upon application of the holder of a lease issued by a state on submerged lands beneath navigable inland waters within its boundaries, may certify that the United States claims no interest in such lands or their mineral deposits. In the event of controversy between the Government and a state as to whether submerged lands under state lease are in inland or marginal waters, an agreement may be made respecting continuation of operations pending settlement of the controversy.

No interruption.—Explaining that there is no likelihood that any legislation dealing with the tidelands can be enacted this year, O'Mahoney declared he introduced his resolution because "it is essential in the national interest that there should be no interruption of the development and operation of oil deposits in the submerged lands."

The legislation, he said, would permit uninterrupted development of the California offshore fields in the event the stipulation which has covered operation since the Supreme Court decision in 1947 is not continued beyond its present final date of September 30, as indicated by objections said to have been raised by the Interior Department. It would also cover operations off Texas and Louisiana, on which the Supreme Court has not yet made its final decrees.

"If there is no legislation," O'Mahoney pointed out, "the delay occasioned by the slow process of the issuance of court decrees and the determination of the applications of the states of Louisiana and Texas and for rehearing would raise such obstacles to operation and development that the United States would probably be deprived of oil production from these lands at a time when it will be needed in the national interest. At the same time, both the states and the industry, as well as the people of the United States would suffer."

Basis for War

Government asks plans for mobilization of oil industry

WASHINGTON.—The Interior Department called on the National Petroleum Council this week to develop the basis on which mobilization of the oil industry will in part be planned.

At the same time, NSRB Chairman Stuart W. Symington advised the council that in the event of an emergency oil, as in the last war, would be put under the administration of the Interior Department, and OGD Director Hugh A. Stewart reported that plans for an emergency organization already have been drafted.

The council's midsummer session July 25 came as the Government was taking its first steps to build up the military and industrial potential of the nation. It was reminiscent of the first meeting of what was to be the Petroleum Industries War Council 24 hours after the attack on Pearl Harbor in 1941, with discussions centering around the problems that would have to be faced in providing enough oil for war on any scale that may develop.

The primary interest of the department was in securing through the NPC up-to-date information on the oil industry's manpower needs, its steel requirements, storage capacity, military requirements, and transportation.

Of these, steel and manpower were represented as the most pressing, the former because shortages of materials, particularly tubular goods, already are being felt and the latter because of the serious problem that will be raised by the recall to duty of oil-company employes holding reserve commissions, a large percentage of whom are in positions which require 2 years or more of training to fill.

The NPC meeting originally was expected to be a routine session at which reports would be submitted by committees studying oil imports and liquefied petroleum gases, with possibly a progress report on the cost of producing synthetic liquid fuels. The most important matter, it was anticipated, would be disclosure by Secretary Oscar L. Chapman of his plans with respect to the Oil and Gas Division for which Congress has refused to make a specific appropriation.

In the light of the current situation, there was no question of the future of the OGD and the government-industry cooperative arrangement through the council, which now become highly important cogs in the industrial-mobilization machine.

Because of the Korean war, the NPC committee made no recommendations designed to cut back imports of foreign oil. It did, however, recommend that a close watch be main-

WATCHING WASHINGTON

Bertram F. Linz

Lesson of History

Congress is considering legislation under which it is expected steel supplies shortly will be put under governmental control, and oil operators are fearful of a repitition of the situation in the last war when it seemed, at times, that War Production Board officials believed that oil produced, refined, and transported itself.

Everyone hopes the Government will avoid the mistakes it made less than 10 years ago, and there are plenty of oil men capable of helping it do so. Biggest help, however, may be the oil history of the war years published by the Petroleum Administration for War, the only agency to set down in printed form the experiences of 1941-45 and the lessons they taught.

So badly handled was the oil-materials program that the PAW story specifically mentions "the lack of appreciation and knowledge, among many Washington officials, of the essentiality of the oil program."

"This was particularly true in the early years of the war, and it required vigorous and lengthy argument to convince these men that the petroleum industry would not only have to have material, but lots of it," the PAW historians commented.

"It was this lacking of understanding of the petroleum industry's needs that brought about the second part of the materials problem—getting high enough priorities to get the materials fabricated. And even when this difficulty was overcome in large measure by better priority ratings, a new hurdle had appeared: So many competing programs had been given equal priorities that it was a grim struggle to get deliveries in time.

"From beginning to end, the oil industry's materials story was a story of fighting to get what it had to have to get the war job done."

Master Planning

The 20-chapter war powers legislation on which the National Security Resources Board spent more than 2 years and under which it would have been the mainspring of the whole industry-control organization has been scrapped and a new plan is now being worked up.

While the new draft is far from complete, it reportedly abandons the idea of converting the NSRB from the planning agency which it is now to an operating agency which would direct all war controls, and returns pretty much to the formula worked out in the past war of having a central agency, then the Office of Emergency Management, and a number of subordinate agencies to handle specific controls.

The idea of a single over-all agency is given support in the pending legislation providing priority and allocation powers for the President, in which it is provided that, as in the last war, the Department of Justice is to assure immunity from antitrust prosecutions for actions ordered by the President but stipulates that the authority to request clearances from the attorney general shall be delegated "only to a single official of the Government."

As the Korean situation tightened up, the various agencies concerned with war materials put all information regarding future steps under wraps, but there were indications that increased secrecy was less the result of impending important moves than an actual lack of idea as to what the President would do next.

The new program to be worked out by the NSRB is being kept highly secret, but it is expected that it will cover the waterfront of wartime mobilization. Unless it is whipped into final shape in the near future, however, the board may find the President has outpaced it in setting up controls.

Grain-Alcohol Pushed

Decision of the Government to step up synthetic-rubber production is expected to touch off a demand for reactivation of at least one of the three wartime grain-alcohol plants for the production of butadiene.

Sen. Guy M. Gillette of Iowa, who spearheaded the movement which resulted in including grain-alcohol in the wartime rubber program, is studying the possibilities of again providing an outlet for agricultural products, such as the Government's embarrassing stocks of surplus potatoes.

During the war, three plants were built to make alcohol from grain, one at Omaha with a capacity of 22,750,000 gal. a year, another at Kansas City, Mo., with a capacity of 15,000,000 gal., and a third at Muscatine, Iowa, with a capacity of 10,200,000 gal. The total cost of the plants was $13,664,000.

tained and expressed the belief that there should be no further distortion of the relationship between domestic and imported oil.

The report suggested that the Interior Department call on importing companies for monthly estimates of imports for the following 3 months, incorporate that information in the Bureau of Mines monthly petroleum statement and issue weekly reports on current receipts of foreign oil.

The NPC discussion of the steel situation showed that the industry has been alerted to the possibility of shortages, either as a result of excessive demand from other industries or, in the future, by failure of the Government to realize the need for supplying materials to develop oil production to war levels.

In the report on military requirements by Bruce K. Brown, chairman of the Military Petroleum Advisory Board, and a discussion of the situation by Rear Adm. B. B. Biggs, chief of the Munitions Board Petroleum Division, it developed that military oil requirements will increase substantially as a result of the Korean war and the decision to increase our armed forces, and that the greatest difficulty in supply is expected to arise in aviation fuels, where drastic steps may have to be taken by refiners to insure fulfillment of all demands.

The most critical ingredient, Brown said, is alkylate for 100-octane fuel for both civilian and military use. Until recently airline use has been greater than military use, but the situation now is reversing and it appears to the committee that all of the alkylate plants now running should be operated at 100 per cent capacity. Also, he brought out, in the absence of any great demand for aviation gasoline some alkylate has been finding its way into civilian motor gasoline and there is a question now whether it should be so used.

Even if all alkylate is put into aviation gasoline, Brown reported, it does not appear that the problem would be solved. There were 56 alkylation plants operating during the war, but the number in service now is believed to be only around 40. At the request of OGD Director Stewart, a detailed study of the situation will be made.

Because of the uncertainties of the situation the council agreed that it should be alert to any sudden development and accordingly, instead of adjourning for 3 months as has been the practice heretofore, recessed subject to the call of the chairman.

Synthetics Program Extended

WASHINGTON.—Extension of the Bureau of Mines' synthetic liquid fuels program for another 3 years from April 1952 was approved by the House of Representatives last week, in part because of fears of a new war with oil requirements in excess of

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ability to supply them from natural petroleum.

The bill carried an additional appropriation of $27,600,000, making the total provided for the program since its inception in 1944 $87,600,000. Of the additional fund, $2,600,000 is earmarked for the construction and equipment of an experimental station at Morgantown, W. Va.

No opposition was offered to the bill when it reached the floor of the House, where Rep. Harley O. Staggers of West Virginia pointed out that to all intents and purposes the United States is at war again, and is hard pressed for chemicals and byproducts of coal and oil.

"We cannot afford to stop the program," Staggers said, "lest we be caught in oil like we were in rubber at the start of the last war."

INDUSTRY AFFAIRS

Pipe-Line Innovation

Shell tells how "push button" products system works; will provide simplified operation, increased capacity

Dahl M. Duff

NEW YORK.—The four new "push button" booster stations which Shell Oil Co. officially inaugurated last week are the latest innovations on an already highly centralized products pipe-line system.

From Shell's head offices in the RCA Building in New York, the movement of a wide range of batched products is closely controlled by the use of teletyped reports and a system of paper tapes showing volumes and locations on nearly 800 miles of company lines.

To this have now been added the four remote control automatic stations in Illinois and Indiana. Personnel in the dispatcher's office in New York start and stop these stations and obtain pressure and amperage readings by dialing the proper numbers on a telephone instrument in New York.

The four additional stations have made possible an increase in average capacity of the line from 29,500 to 34,000-35,000 bbl. daily without a significant increase in the unit cost of operation. By centralizing automatic control in New York, takeoff of products at the intermediate terminals can be accomplished without loss of electrical power. Over-all balancing of the line for the various petroleum fractions transported is made much simpler, and tankage requirements are kept at a minimum.

Shell has for some time exercised centralized control from the New York office over movements in the following lines: The 450-mile system from Wood River, Ill., to Toledo and Columbus; 250 miles from Wood River to East Chicago, Ind.; and 81 miles from Fall River, Mass., to West Boylston and Waltham, Mass. There are 13 terminals on these lines. In addition, Shell's New York office controls operations at the eight company terminals on the Houston-North Carolina Plantation system.

Hourly reports.—From stations along the company-operated lines, hourly reports are received by teletype in the New York dispatcher's office. Corrections are made for temperature and pressure on the volume of the various products en route.

Movement of products through the system is followed by means of scaled paper tapes placed along a 17-ft. control board. Different colors are used to represent different products, and when material is taken off at a terminal, the corresponding length of tape is removed. Cross sections of the lines showing elevation are mounted before the board for quick reference in case of a break.

The four new automatic stations are located on Shell's East Products Pipe Line extending from Wood River to Columbus. They represent still another major step in centralized operation and, according to Sidney Smith, head of Shell's products pipe-line system, are the first time that long-distance leased telephone circuits have been used to control pipe-line operations in the field.

The new stations, at New Douglas, Effingham, and Dennison in Illinois, and North Salem in Indiana, were added to the 8-in. line to meet the increased demand for system capacity, particularly during the winter months when heavy shipments of fuel oil are made. They are equipped with 500-hp. explosion-proof motors and 6-stage Byron Jackson pumps.

Engineers of Shell, General Electric, and American Telephone & Telegraph collaborated in designing the electrical setup which allows the station to be controlled from the central dispatching point 850 to 950 miles away in New York. Bailey Instrument Co. provided the telemetering equipment used for reporting pressures and electrical loads.

Code-letter control.—Teletype relay equipment at each of the four stations functions in conjunction with the G-E MI-9 switchgear as a part of the complete system of switchgear, control, and necessary equipment. These relays permit the switchgear to set up a "station run" sequence at any one of the four stations when the proper code letter is dialed in the New York dispatcher's office. The sequence causes the following automatic operations:

(1) Starts an oil-pressuring pump to lubricate seals in the main pump,

Control panel in the new Shell remote-control automatic booster station at Dennison, Ill., one of four such stations on the products line.

(2) opens the motor-operated suction valve, (3) starts the 500-hp. pump motor (full voltage start), and (4) opens the motor-operated main-discharge valve to bring the station on line.

Shutdown is affected by opening the "station run" relay which shuts off the pump motor and simultaneously closes the motor-operated valves. A mechanical check valve in the line permits flow past the pump when these valves are closed.

Dialing another code letter allows the dispatcher in New York to read the instruments at any one of the four stations in rapid sequence over the teletype system. A pulse-duration telemeter system in conjunction with the pressure-recording instruments both ahead of and behind the pump and motor-current recorder, causes the teletype to transmit letters which can be read by the dispatcher in terms of instrument readings.

Readings from the instruments are received back in New York within 45 seconds from the time of dialing. A line consisting of the letter D is transmitted for discharge pressure, S for suction pressure, and A for amperage. These lines are scaled for length which represents the correct reading.

Safety devices. — To assure against equipment failure or fault in operation, each station is equipped with a complete complement of safety shutdown devices working on temperature, pressure, gas accumulation, etc. If one of the devices trips, the station shuts down, and an annunciator in the MI-9 equipment registers the cause of the trouble. When this happens, the station is locked and restarting is impossible until an attendant is called and the trouble located.

Pump bases and pump mounting are arranged so as to permit future installation of 900-hp. base-ventilated motors. This design was approved after a cost-study of three systems showed favorable results under certain loadings for adjustable-speed electric-motor drive. Swithgear and instrumentation is also arranged so that it can work with the 900-hp. motors, since it is anticipated that further increase in load on the East line within the next few years will justify the larger motors and possibly the adjustable-speed drive.

One man is assigned to each of the remote-control stations to perform routine maintenance and upkeep and for manual operation if it becomes necessary. The teletype system from New York also includes a signal to set off a siren at the station to summon the attendant.

Operation of the stations "wide open" and without throttling is possible because the pressure boost is limited to about half the safe working pressure of the line. With throttling losses eliminated, application of power is on a more efficient basis, and the flexibility is such as to allow immediate product takeoff without power loss, Shell said.

The East Products system of Shell was completed in 1938 with an initial capacity of 16,000 bbl. daily. Three new stations were added in 1940 to bring capacity to 25,000 bbl. daily. Another addition in capacity was obtained with the installation of larger pumps after the war. The four new remote-control stations raise present capacity of the line to well above twice what it was originally.

Smith said the advantages of the automatic remote-control operation were its "foolproof" nature and the fact that a greatly increased flexibility is obtained. Several months were spent working out the special equipment, and the entire control system involves a "marriage of several techniques," he said.

Discussing the over-all operation, Smith said that in 13 years of running products ranging from L.P.G. down through distillate fractions and including special solvents, the department had never had a bad mixture. Clean cuts, he said, are obtained by using relatively high velocities of about 5 m.p.h., and at no time is the line ever allowed to become slack. There is no shutdown except in case of an emergency.

Octane Race Halted

Motor fuel ratings hinge on military needs resulting from threat of war; no cutback in quality expected now

George Weber

NEW YORK.—A definite halt to the octane race has been called, at least for the time being, as a result of the Korean situation and the prospect that the military may require large quantities of high-octane aviation gasoline.

The present high levels of octane numbers of motor fuel throughout the country may remain as they are for some time, or they may back off slightly. Octane cut-back is contingent on future military needs for aviation gasoline and other military fuels.

Additional requirements now projected for the remainder of this year do not appear to be large enough to require an over-all reduction in civilian fuel quality, but they augment an already tight octane situation to make a further upward trend in civilian gasoline ratings highly improbable.

Even before the Korean situation arose, the octane race appeared to be levelling off. Many major and independent companies have now reached or are closely approaching the limits which their present facilities can supply in the quality and quantity demanded for successful competition. Premium grades are generally in the 92 and 93 research octane class in Eastern, Gulf Coast, and Pacific markets. They range from 90 to 91 in the interior and slightly lower in the Rocky Mountain area. Regular grades have reached 85 to 87 research octane in most of the heavy-consumption areas.

To meet this quality, some companies have resumed or expanded alkylation operations. Many are blending 2.5 cc. of tetraethyl lead and some are approaching or have reached the limit of 3 cc. per gallon. Thus even before Korea, quality of motor gasoline was approaching its limit with existing facilities and could be improved substantially only with some reduction in gasoline yields.

Military needs. — Superimposed on this already tight civilian octane situation is a certain increase in military requirements for aviation gasoline. Military procurement officials have told industry representatives how much additional aviation fuel they will need in the near future to fight in Korea and bolster stocks in other strategic world points. While that figure has not been made public, it is known to represent so small a fraction of total octane-barrels now produced over all, that it will not materially affect the octane of present civilian gasolines.

This is the short-range picture, holding for the next few months. The prospect over a longer period is anyone's guess. Continued increases in aviation gasoline and jet fuels could require extensive cutbacks in both quality and quantity of civilian gasoline, but military requirements as now indicated can be met it is said, without affecting the motoring public for the time being.

Following the latest Military Petroleum Advisory Board meeting in Houston in mid-July, a delegation of military procurement officials visited New York last week to discuss with refiners ways and means of filling expanded military requirements. Reports that they were here to sound out the industry on possible civilian octane cutbacks were denied. Just how such cutbacks could be effected across the board in the absence of wartime controls is not known, short of a voluntary refiners' agreement with a Department of Justice blessing.

The pressure for supplying high-octane blends is by no means slackening. The present halt is called by the need for supplying immediate military requirements. In the absence of any all-out military effort which

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would obviously depress civilian octanes, the race will continue in the long range as new manufacturing facilities are placed in operation.

New facilities.—A number of refiners now hard pressed to meet competitive quality are now building or will shortly add new catalytic cracking and reforming units, which will allow them some margin on present octane requirements. In addition, several new processes and improvements on existing ones are receiving intensive development in laboratories and pilot plant.

Catalytic reforming is getting particular attention. In addition to the Platforming process, now operating in one refinery and projected for several others, at least three other improved catalytic reforming processes are known to be in advanced development stages. An improved fluid catalytic cracking process is reported to be in an advanced stage of development by a major oil company. Hydroforming is also due for a new look, according to well-founded reports. The small refiner is being courted with catalytic processes adapted to small lower-cost units.

The current construction of new refinery facilities aimed at greater volume and higher quality in gasoline, plus a strongly revived research effort toward the same ends will bolster this country's productive capacity for high-octane fuels over the next few years. Where these high-octane components will go is a matter of priority. Should military needs expand substantially, high-octane blends will be funneled into aviation gasoline, with civilian gasoline remaining as is, or suffering setbacks. Barring military procurement well over present estimates, the octane race may resume after a temporary halt.

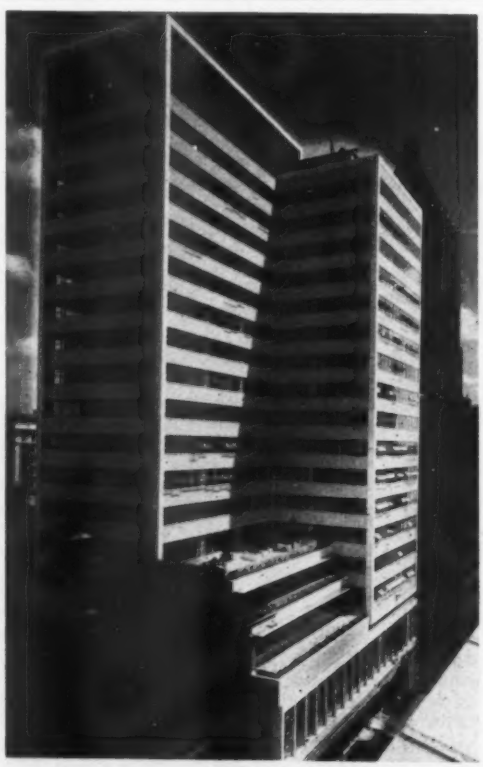
Penn Crude Price Raised

Improved demand for lubricating oils has resulted in another increase in the prices paid for Pennsylvania Grade crude oils.

The Joseph Seep Purchasing Agency of South Penn Oil Co. announced an increase of 14 cents a barrel for all areas where the company purchases crude. Under the new schedule, effective July 19, the company will pay $3.89 for Bradford-Allegheny crudes and $3.46 for crudes from southwestern Pennsylvania districts. Pennsylvania Grade oil from Ohio delivered to Buckeye Pipe Line Co. and West Virginia oil delivered to Eureka Pipe Line Co. sell for $3.40 under the new posting.

Ashland Oil & Refining Co. announced an increase of 5 cents a barrel for Zanesville crude to $2.95, effective the same date.

Bradford crude now sells for 49 cents a barrel more than at this time last year, after four increases starting in December. The first gain, effective December 12, raised the price 14 cents. The new posting on May 1 amounted to an increase of 11 cents, and the change on June 21 added another 10 cents.



***OIL CENTER.**—A new center of oil activity in Tulsa opened this week, the 20-story building constructed jointly by First National Bank & Trust Co. and Sunray Oil Corp. Sunray occupies the top seven stories and the bank, which is quite active in oil financing, has banking quarters on the mezzanine and lower floors, reached from the street by escalators. A number of other oil operators have taken space in the building. Nearly 2 years in construction, the building is completely modern in design and equipment. The bank's formal opening this week coincides with its fifty-fifth anniversary.*

Danciger Stock Sold

FORT WORTH. — Danciger Oil & Refining Co.'s controlling interest has been sold to Southern Production Co., Shreveport, for $40,934,700.

Dan Danciger, president of the firm, said that the 1,637,388 shares, which represent the Danciger family's controlling interest, was purchased by Southern Production for $25 per share.

All employes of Danciger are to be retained by Southern in their present capacities and salaries for at least a year, Danciger said, and Southern will extend to all other stockholders of the Danciger company an offer to purchase their shares.

Organized in 1927, the present Danciger company has 500 employes. Operations are carried on in Texas, Oklahoma, Louisiana, New Mexico, and Mississippi.

Southern Production is the producing subsidiary of Southern Natural Gas Co., Birmingham, which has gathering lines in Texas. The transaction will add approximately 600 producing wells, large natural-gas reserves, and a refinery at Pledger, in Brazoria County, Texas, to Southern's properties.

MEETINGS

A.A.P.G.-S.E.G. Dates Set

A regional meeting of American Association of Petroleum Geologists and Society of Exploration Geophysicists will be held at the Banff Springs Hotel in Banff, Alta., Canada, September 5-8, under sponsorship of the Alberta Society of Petroleum Geologists. It will be held jointly with the Geological Association of Canada.

A varied program has been planned, with 27 papers to be presented by experts in their field. For the most part, the program will offer a complete coverage of petroleum geology in western Canada, with particular emphasis on bioherm and biostrome reefs in the Paleozoic. Included will be several papers on reef trends and configurations and theory of origin and development. A paper which discusses the newly prepared Tectonic map of Canada also will be presented.

Included will be a symposium on geophysical working methods, and two field trips will be conducted. These will cover the Banff area and the Bow River Valley and Rocky Mountain front.

N. E. Tanner, minister of lands and mines of Alberta, will deliver the opening address on September 5, and an introductory address will be given by George S. Hume, director general of the Mines and Technical Surveys Branch of the Dominion Government, Leslie M. Clark, Seaboard Oil Co., Calgary, Alta., is general chairman of the program committee.

TEN EXTRA TANKS.—The trunk compartment of each car in the Du Pont fleet holds ten auxiliary fuel tanks. Six of these are for reference fuels and four are for test fuels. The reference fuels are made to 92.5, 90, 87.5, 85, 82.5, 80 octane number and are blends of isooctane and n-heptane. Fuel lines from each tank are attached to solenoid valves with quick release fittings. The valves are actuated by pushbuttons on the instrument panel. A fusible plug setup is designed to ring an alarm bell in case of fire. Carbon dioxide gas can be instantaneously released to flood the trunk compartment through a button at the driver's position.

NOT FOR WOMEN DRIVERS!—The special instrument panel of the test cars displaces the original dashboard. The pushbuttons for venting, for tank fuel, and for reference and test fuels are in line on the lower part of the panel. Above them are red warning lights which indicate the fuel being used. To the left of the buttons is the exhaust pressure indicator. From left to right in the upper portion of the panel are intake vacuum, engine speed, spark advance indicators, and a temperature selector dial and temperature indicator. On the floor of the car can be seen the window through which flywheel calibrations are read, via stroboscopic lighting, and the operating handle which controls spark advance settings.

Test Fleet

Du Pont scatters 31 autos over nation to test fuels

IF you see a shiny, olive green 1950 automobile bearing a New Jersey license and carrying in neat gold lettering on its sides "Du Pont Fuel Test Car," you have seen one of a fleet of 31 special gasoline test cars scattered across the country.

The latest three cars added to the fleet are now on a 15,000-mile tour of the nation. The fleet cars are virtually laboratories-on-wheels. They are used for determining performance ratings of motor fuels under road conditions and are shown to refining, marketing, and research groups in demonstrating methods of rating gasoline.

Outwardly the cars look like standard 1950 automobiles. But not inside. The dashboard has been replaced by an elaborate instrument panel, and in addition to the conventional gasoline tank, 10 smaller tanks have been installed in the luggage compartment.

Two gallons of each of the gasolines to be tested for road performance are placed in the designated special test tanks. A battery of pushbuttons on the instrument panel permits the driver to draw gasoline from any of the tanks.

Also on the panel an aircraft-type gage makes it possible for the operator to determine temperatures of engine, radiator water, oil, and outside air. Other instruments show manifold vacuum, engine speed, back pressure of the exhaust, and spark advance.

The test autos are equipped with a hydraulic device which allows the driver to advance or retard the spark. Spark changes, coupled with engine-speed readings, provide information which helps determine octane values. The degree of spark change is visible to driver or observer through a window in the floorboard and an opening in the flywheel housing.

NEXT WEEK

Abqaiq—World's Largest Producer.—This is the field operated by Arabian American in Saudi Arabia. First of a series of articles by Paul Reed, the Journal's pipe-line editor, who recently visited drilling-producing-pipe line activities in the Middle East oil countries.

Big Gas User.—Aluminum Co. of America has installed huge new aluminum production plant near Port Lavaca, Tex., where 2,750,000 kw.-hr. of power are generated each day, for aluminum production. Plant has 120 gas engine-generator units of unique design, as such is one of largest installations of internal-combustion engines in the world. Article by L. S. McCaslin, Jr., Gulf Coast district editor, describes the gas-fueling aspects.

Runnels County.—This is another of those West Texas areas very active in drilling developments. The writeup by Roy Carlson, of the Journal's Dallas office, is latest in a regular series of articles on "Active Fields."

Packaged TCC Unit.—Design and operating information, flow setup, equipment details, presented by Journal's refining editor.

Refinery L.P.G. Operation.—Short article on new installation at Sinclair's Marcus Hook refinery, by H. F. Thompson, chief of technical department there.

Oil in Western Canada.—Exploration, drilling, producing, pipe line, refinery aspects discussed by Dr. Oliver D. Hopkins, vice president, Imperial Oil, Ltd.

Heat Savers.—Report of performance of thermal poly transeconomizers, by J. H. Smith, chief process engineer, Continental Oil Co.

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New Engine-Wear Test

Radioactive piston rings used by Atlantic give accurate picture of lube-oil effects after only short test runs

George Weber

RADIOACTIVE piston rings are the key to a rapid, precise method for testing the effect of lube oils on engine wear. The new technique which scientists of Atlantic Refining Co. originated 7 years ago, has been greatly improved by the advent of the atomic pile.

The new test method now in routine use at Atlantic's Philadelphia research laboratories, permits determination of engine wear after very short periods of engine operation. Comparative runs using many different types and grades of lubricating oil are possible under identical operating conditions.

Formerly, engine-wear tests required runs up to 500 hours, after which the engine was torn down and critical parts removed and weighed to determine loss by wear. Long runs and the necessity for engine disassembly prevented comparative tests of oils under exactly similar operating conditions.

The new technique requires runs of only about 3 hours, corresponding to about 200 driving miles. Many lubes may be tested without removal of the engine head, providing more exact comparison of engine wear using different motor oils.

Ring technique.—The new method differs from the conventional test only in the substitution of a radioactive top piston ring in the test engine. During engine operation, minute particles of radioactive iron are worn from the "hot" ring and become suspended in the crankcase oil.

Following the brief running period, the oil is withdrawn from the crankcase and a sample is poured into a specially designed graduate. A metal cylinder containing a Geiger counter is dipped in the sample and the amount of radioactive iron suspended in the oil is immediately recorded. The positive radioactivity counts of various oil samples run consecutively under identical conditions provide a direct correlation of the wear protection afforded the test engine.

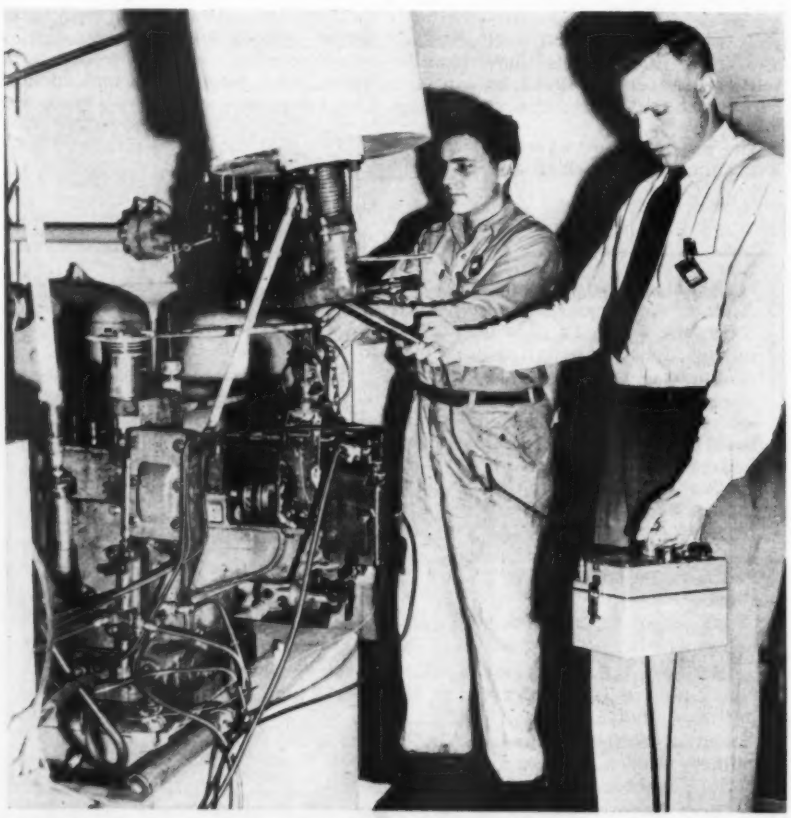
The piston rings were made on special order from a common melt to assure their precise uniformity. Otherwise they do not differ from rings obtained from conventional sources. They are shipped, as needed, to the Atomic Energy Commission and exposed under accurate control to the same degree of radiation in the pile at Oak Ridge, Tenn. The radioactivity of the rings declines so rapidly that they are used for test purposes for only 3 weeks.

Atlantic engineers have devised special tools for the safe handling of the radioactive rings. As illustrated, long-handled tongs are used to spread the ring and set it into the top piston groove. Another tool compresses the rings as the piston is fitted into the cylinder. At no time is the operator required to come into dangerous proximity to the radioactive material.

Original work.—Atlantic pioneered in the use of atomic energy in petroleum research and was granted a patent in 1943 on this method of wear testing. At that time, engine parts were irradiated in a cyclotron, long before the atomic pile at Oak Ridge was made available for such work. The method proved feasible at that time, but the degree of radioactivity obtained in the cyclotron was much less than that now obtainable, and present test runs provide much greater accuracy for shorter test runs.

Hugh R. Jackson, shown holding the Geiger counter, directs the engine-wear research project at Atlantic laboratories. He is one of three members of the laboratory staff who have completed the course in safe techniques of using radioisotopes in research, conducted by AEC at the Oak Ridge Institute of Nuclear Studies. Other graduates are Dr. Samuel W. Levine and Dr. John H. Ramser, who are studying other applications of atomic energy in petroleum research.

The cumulative radiation to which research personnel have been exposed over fixed periods is measured by the devices shown clipped to their shirt pockets. These are examined regularly to assure that each operator does not approach the amount of radiation which might prove injurious. Clifford J. Wirth, left, shown holding the tongs is the operator of the "hot" test engine, under the direction of Hugh R. Jackson, who is checking the amount of radiation with a Geiger counter.



Technicians at Atlantic Refining Co.'s Philadelphia research laboratories are shown preparing radioactive piston rings for engine-wear test.

New Record Output

World production reaches another all-time high in spite of drop in Venezuela; Middle East, U. S. show large gains

Dahl M. Duff

AN all-time high in world crude-oil production was established in May with a total averaging approximately 9,842,000 bbl. daily.

This record volume was accomplished despite the fact that Venezuelan production dropped off sharply as a result of the week-long strike in that country early in the month.

The other two principal world producing areas, the United States and the Middle East, both showed marked gains. During 1949 and the early part of this year, the decline in United States production consistently held the world total below the record output reached late in 1948.

The 9,842,000 bbl. daily produced in May compares to 9,742,000 bbl. daily the previous month. The May figure also exceeded production in December 1948 when world output averaged 9,783,000 bbl. daily. The figures include the best available estimates for Russia and Eastern Europe.

The May world total of 9,842,000 bbl. daily represents a gain of about 1 per cent over April. When compared with May 1949, the gain is about 642,000 bbl. daily, or nearly 7 per cent.

United States production in May is estimated at 5,121,000 bbl. daily. This is an increase of more than 152,000 bbl. daily over the previous month. The May total is still, however, some 567,000 bbl. daily below the United States record of 5,688,000 bbl. daily in December 1948.

Excluding the United States and the Russian-controlled areas, foreign production during May dropped off 52,000 bbl. daily to 3,866,200 bbl. daily. This was almost wholly accounted for by the shutdown in Venezuela. The Middle East, on the other hand, set a new production record in May at 1,766,600 bbl. daily.

Latin America. — Venezuelan production in May clearly showed the effects of the labor trouble. The big fields in Western Venezuela in the Lake Maracaibo area took the heaviest reductions (see accompanying table) with Lagunillas down nearly 60,000 bbl. daily under its April production.

The production trend in Venezuela since the strike has been rapidly upward. In the week ended May 22, output was above the pre-strike level with 1,497,900 bbl. daily, and in the week ended May 29, it reached 1,512,700 bbl. daily. Weekly figures show continued gains during June and the early part of July.

Venezuela's May daily average of 1,252,400 bbl. was the lowest production in that country since April 1949. The May figure was 189,000 bbl. daily, or more than 13 per cent, below the previous month. Included during May were 875,000 bbl. daily in Western Venezuela and 377,255 bbl. daily in Eastern Venezuela.

PRODUCTION OF MAJOR VENEZUELAN FIELDS

(10,000 bbl. daily or more)

—Field—	May	April
Western Venezulea:		
Cabimas	75,660	85,085
Lagunillas	324,944	384,679
Tia Juana	129,911	153,412
La Paz	121,259	148,885
Bachaquero	91,881	108,848
Mene Grande	34,936	48,555
El Cubo	10,374	11,585
Mara	57,568	72,797
Eastern Venezuela:		
Quiriquire	50,552	53,721
Oficina	31,889	37,333
Jusepin	17,400	18,164
Mulata	16,163	19,100
Nipa	35,289	37,502
Las Mercedes	18,583	18,628
Taman	9,579	10,752
Santa Barbara	20,816	20,354
Guico	10,303	11,099
Guara	49,278	51,357
Chimiri	33,182	32,078

Production in Colombia declined slightly in May from the all-time record of the previous month. However, as a result of the opening earlier this year of the new stations on the Andian National line, Colombia's output during this year is expected to average about 95,000 bbl. daily.

Another production increase was shown in Mexico during May, according to preliminary reports. A considerable part of the increased production in Mexico is being obtained by continued development in Poza Rica. In March of this year, 61.8 per cent of Mexico's total production was from Poza Rica as compared with 56.8 per cent in 1947. Adding to the Poza Rica production is the new development in Escolin.

Western Germany in May continued the steady increase in crude production that has been taking place over the last year and a half. The May daily average of 21,400 bbl. was equivalent to 93,778 metric tons. The increase over April was confined almost exclusively to Emsland where 44,337 tons were produced in May against 40,200 tons in April. France showed an increase in its small domestic output, apparently the result of development of the new Lacq area near the Pyrennes.

Middle East.—Total production in the

CRUDE-OIL PRODUCTION

(Thousands of barrels daily)

Country—	May 1950	Previous month	May 1949
Western Hemisphere:			
Argentina	69.0	69.0	61.5
Bolivia	2.0	1.7	1.8
Brazil	0.6	0.9	0.2
Canada	62.4	65.9	54.3
Chile	1.5	1.5	...
Colombia	93.0	94.3	87.1
Cuba	0.4	0.4	0.2
Ecuador	7.0	7.3	7.2
Mexico	194.2	188.8	165.7
Peru	41.0	41.0	40.6
Trinidad	57.0	56.0	56.3
Venezuela	1,252.4	1,441.4	1,292.0
Total	1,780.5	1,968.2	1,766.9
Middle East:			
Bahrein	29.3	30.0	30.2
Iran	683.8	685.4	566.8
Iraq	135.3	122.2	60.3
Kuwait	341.5	305.5	258.1
Turkey	0.8	0.8	0.3
Qatar	25.0	30.0	...
Saudi Arabia	550.9	465.6	502.2
Total	1,766.6	1,639.5	1,417.9
Other Asia:			
British Borneo	82.0	80.0	69.3
Burma	0.5	0.5	0.5
China	1.3	1.3	1.5
India	5.5	5.5	5.3
Indonesia	130.0	128.0	121.5
Japan	5.4	5.2	3.8
New Guinea	4.8	4.8	3.6
Pakistan	3.2	3.2	1.8
Total	232.7	228.5	207.3
Europe and Africa:			
France	1.5	1.4	1.1
French Morocco	0.7	0.7	0.3
Germany	21.4	21.2	14.7
Italy	0.2	0.2	0.2
Netherlands	14.4	13.7	11.3
Egypt	47.0	43.6	45.0
United Kingdom	1.2	1.2	0.9
Total	86.4	82.0	73.5
Total foreign less Russia, Eastern Europe	3,866.2	3,918.2	3,465.6
Estimated Communist-controlled areas:			
Austria	22.0	22.0	18.0
Romania	80.0	80.0	92.0
Russia	730.0	730.0	635.0
Other E. Europe	22.5	23.0	17.0
Total	854.5	855.0	762.0
Total, foreign	4,720.7	4,773.2	4,227.6
United States	5,121.0	4,968.4	4,972.4
World total	9,841.7	9,741.6	9,200.0

Figures given are from reliable reports in the industry or from official government sources. Data for Russia and Eastern Europe are based on competent estimates; no authentic information is available on production in these areas.

XUM

Middle East in May increased about 127,000 bbl. daily, or 7.8 per cent, over the 1,639,500 bbl. daily produced in April. The May daily average represents a gain or nearly 25 per cent over production in May 1949.

Two of the four major producing countries of the Middle East established new production records in May. Saudi Arabian production at 550,900 bbl. daily was up 18.3 per cent from April and was the highest since February 1949 when 532,300 bbl. daily was reported.

The other record was in Kuwait which had a daily average in May of 341,500 bbl. daily. This compares to 305,500 bbl. daily the previous month, a gain of 11.8 per cent. Kuwait's May production was 83,400 bbl. daily, or nearly 33 per cent, greater than in May 1949.

Production in Iran, which has been at record high levels in recent months, dropped off slightly in May to about 683,800 bbl. daily. Iranian output, however, was still about 21 per cent above a year ago. A gain was reported in Iraq from which an increased amount of Kirkuk crude is moving through the pipe lines to Tripoli.

TREND OVER LAST YEAR

1949—	Western Hemisphere less U.S.	Middle East	Total foreign less Russia & E. Europe
June	1,768.8	1,375.7	3,433.3
July	1,800.2	1,338.7	3,428.1
August	1,859.9	1,323.9	3,473.1
September	1,931.8	1,351.5	3,574.9
October	1,921.6	1,428.6	3,645.9
November	1,925.9	1,472.7	3,683.0
December	1,929.3	1,489.6	3,711.0
1950—			
January	1,946.5	1,491.4	3,733.4
February	1,820.6	1,566.6	3,689.4
March	1,900.4	1,607.4	3,812.9
April	1,968.2	1,639.5	3,918.2
May	1,780.5	1,766.6	3,866.2

Russian report.—While official secrecy obscures exact appraisals of oil production in Soviet Russia and its Eastern European satellites, recent Russian newspaper accounts indicate the difficulties being encountered in Russia's oil fields.

Russia's largest producing area is still Baku which was scheduled for about 17,000,000 tons (340,000 bbl. daily) under the current 5-Year Plan. In 1940 Baku produced some 22,000,000 tons a year, but during and since the war, Russia has been attempting to develop fields farther east.

According to Russian newspapers, oil workers in Azerbaijan Province recently wrote Premier Stalin that many sections of the industry in Baku had not fulfilled their quota last year. It said technological progress is lagging in the Baku area, and that exploration work is proceeding at an unsatisfactory rate. This bears out other reports that efforts to extend Baku production have been only partially successful.

Oil production also is reported to be unsatisfactory in Hungary, another Communist country. Virtually all of Hungary's production was developed by an affiliate of Standard Oil Co. (N. J.) prior to the war. A recent report said production in Hungary in the first quarter of 1950 was only 3.3 per cent above the corresponding quarter of 1949 and that it appeared doubtful if there had been any improvement whatsoever compared with the last quarter of 1949.

Hungary's Three-Year Plan announced in 1947 had a target of 660,000 tons (about 13,500 bbl. daily) in the 12 months ending in August of this year. Present output indicates that the nationalized industry will fall far short of the goal. No oil production goal was mentioned in the new 5-Year Plan.

EUROPE

New Refinery

Germany adds to cracking facilities for heavy crude

CONSTRUCTION work has been started on a new German refinery which is designed to process up to about 12.000 bbl. daily of indigenous production from the Emsland region.

The refinery, scheduled to be in operation in 1952, is being built by Gewerkschaft Elwerath and Wintershall, A.G., two German oil companies, at Holthausen, north of Lingen, in the Emsland region near the Dutch border.

Crude for the refinery is to be supplied by pipe line. Work on this system was undertaken some time ago. The refinery is to be equipped with cracking facilities designed to handle the heavy Emsland crude. Emsland production is now about 10,000 bbl. daily with further increases anticipated.

Other improvement in German refining facilities is taking place in Slesvig-Holstein at Heide where Deutsche Erdoel, A.G., has begun work on new cracking facilities. Completion is expected in about 18 months.

The new plant will provide for an increase in the company's production of gasoline and diesel from the present level of about 225 bbl. daily to about 2,800 bbl. daily of gasoline and about 1,250 bbl. daily of diesel. The enlarged refinery will be used particularly for refining crude produced in the Heide area but will also process some imported oil. This latter will be transported by a pipe line which is planned for construction from Brunsbuettelkoog to Heide.

100,000-bbl. goal.—Western Germany hopes to develop a refining industry of more than 100,000 bbl. daily, using cracking and hydrogenation to meet the relatively heavy demands in the country for light products and to process satisfactorily its domestic production. German officials look forward to a domestic production of at least 30,000 bbl. daily with the remaining requirements to be met by crude imports.

A recent report from Hamburg said the German plans for an increase in refining capacity with new plants and additional cracking units have been approved by the full Oil Committee of the Organization for European Economic Cooperation in Paris. The plans are to be submitted to the Economic Cooperation Administration in Washington, along with estimates of 1950-51 German motor-fuel consumption, and a final decision will depend on ECA's views.

Norse Refinery Operating

A small specialty plant and the only refinery in Norway has been placed back in operation following reconstruction of war damage.

The refinery, located on the Oslo Fiord at Vallo near Tonberg, is operated by A/S Norsk Amerikansk Mineraloljekompagni. This company is a 100 per cent subsidiary of A/S Ostlandske Petroleumscompagni, the Norwegian marketing affiliate of Standard Oil Co. (N.J.).

The plant is operated primarily for the production of lubricating oil and asphalt. Crude is scheduled to come from Venezuela, and the first shipment to resume operations was received some time ago.

Total capacity of the Vallo refinery is 1,000 bbl. daily, but its average year-round operation is expected to be about two-thirds this figure.

The plant was bombed 2 days before the end of the war and almost destroyed. Its reconstruction was carried out with war-damage funds.

MIDDLE EAST

Sterling for Egypt Imports

Sterling payment for petroleum imports into Egypt from Saudi Arabia is being planned in discussions now taking place between the two governments over a renewal of their present commercial agreement.

It was reported in Cairo that the Egyptian Government had expressed the desire that Egyptian ships be given priority in the transportation of goods exchanged between the two countries and that petroleum be paid for in sterling.

It was also said that efforts are being made officially to obtain an agreement with the American operators in Saudi Arabia to the effect that it will sell Egypt its oil requirements against a sterling payment. Saudi Arabia was reported to have approved the principle of priority to Egyptian ships.

Dr. Mahmud Abu-Zeid Bey, director-general of mines and quarries of the Egyptian Government, said recently in Cairo that the govern-

ment had already allocated 820,000 Egyptian pounds for the enlargement and modernization of the government refinery at Suez. After the work is completed in about 18 months, the refinery will be able to produce 1,300,000 tons a year instead of the 400,000 tons a year at present.

Directional Hole for Iraq

A 2,600-ft. directional hole is to be drilled in the near future in Qasab 5 in northern Iraq in order to kill off positively a leaking flow of the heavy sulfurous oil.

Qasab field was discovered in 1935, and the wells have been shut in because of the lack of a market for the type crude produced. Some oil is bubbling around the surface string, and the directional hole was described as a largely precautionary measure in view of the fissured nature of the area and the potential danger of the leak. Little cratering has thus far occurred.

LATIN AMERICA

Mexican Expansion

Percentage contracts awarded for wildcat territory; Ed Pauley and Sharples Oil set for long-term program

TWO new percentage-of-production contracts have been made by Petroleos Mexicanos with United States operators.

According to a Pemex announcement in Mexico, drilling contracts have been awarded to Edwin W. Pauley, California operator, and Sharples Oil Corp., Denver, Colo.

Independent Exploration Co., headed by Pauley, is to explore in northern Tamaulipas. The Sharples contract covers an area described as parallel to Mexico's Golden Lane in Vera Cruz.

Both areas are wildcat territory. Pemex has developed gas production in certain sections of northern Tamaulipas and is carrying out some drilling in the southern part of the state under a financing arrangement with Cities Service Oil Co. which held a concession in this section.

Terms of the two contracts were reported as being the same as those provided in the contract made by Pemex in March of last year with Mexican American Independent Oil Co. Under this contract, the company drilled at its own expense on designated structures. With each structure considered as a unit, CIMA (Mexican American Independent) recovers its expenses out of 50 per cent of the production and is compensated for its work from 15 per cent of the production on upland wells.

Longer term reported.—CIMA, which has drilled several wells in southeastern Mexico under its contract, had a 12-year period of development provided for on upland structures. The Mexico City announcement of the Sharples and Pauley contracts mentioned a 25-year term for these agreements. Under all these Pemex contracts, dry holes are at the operator's expense.

Pauley was associated in the CIMA organization, originally holding a third interest with American Independent Oil Co. and Signal Oil & Gas Co. Subsequently, the American Independent's organization bought 60 per cent of the Pauley interest and brought its percentage in the venture to 53⅓ per cent. It has been known for some time that Pauley was seeking a contract with Pemex on his own account.

Sharples Oil Corp. now has properties in Rangely field, Colorado, in Texas, and is interested in operations in Canada. It is a subsidiary of The Sharples Corp., Philadelphia, which is headed by Phillip Sharples and which manufactures centrifugal equipment. Through a subsidiary, it is interested in a petrochemical operation in Baltimore with Continental Oil Co.

New loan rumored.—Reports persist that Mexico may still receive a loan from the United States for development of its nationalized oil industry. Negotiations were broken off a year ago, but there have been continuing rumors that the funds will be granted.

Edward G. Miller, assistant secretary of state for Latin-American Affairs, who is vacationing in Mexico, said last week in Mexico that any decision about the loan ultimately will come from the White House.

"The State Department believes such a loan should be used exclusively for new refineries and pipe-line equipment," he said. "We believe this country's petroleum production has not yet reached the volume it could in view of the known reserves, and our government should not be asked to lend money to develop a nationalized industry here in competition with United States private interests."

Chile's New Oil Authority

Chile's government oil operation is now being reorganized under a new separate agency, Empresa Nacional del Petroleo, S.A. (ENAP).

The government's Corporacion de Fomento has been in charge of development of Chile's indigenous production which was discovered late in 1945 in the Tierra del Fuego region. Long-range plans include a refinery.

Legislation approved by the Chilean Congress allows the new agency to operate as a separate unit. Of the six members of the board, four represent Corp. de Fomento, one a Chilean institute for promoting industry, and one an association of mining interests. Director of the new ENAP has not yet been named.

The change is expected to provide a more efficient operation of the oil enterprise. ENAP is authorized to enter all phases of the industry, though marketing is expected to continue as at present under private companies.

Gasoline Plant for Chile

Hudson Engineering Corp., Houston, has received a contract from the Chilean Government's Corp. de Fomento for a 30,000,000-cu. ft. a day gasoline plant.

The contract covers engineering, design, and supervision of construction. The plant will be located in the Tierra del Fuego region to process gas from Cerro Manantiales field. Commercial production from the field was begun last October. The current production rate of 1,500-2,000 bbl. daily is not expected to be substantially increased until after the facilities for processing the gas are installed.

FAR EAST

Chinese Reds Seize Oil

Stocks of petroleum products in China belonging to four oil companies were seized last week by the Chinese Communists.

The oil, estimated to amount to about 15,000 bbl., had been shipped into China before the Communists completed their conquest of the country last year. It represented shipments financed by the Economic Cooperation Administration for the Nationalist Government.

The companies holding the stocks were California-Texas Oil Co., Ltd., Royal Dutch-Shell, Standard-Vacuum Oil Co., and Cathay Oil Co. The stocks were located principally in Shanghai.

The action seizing the stocks was announced by the Peking Radio and was in retaliation for the United States-British ban against further petroleum shipments into China. The halt in shipments was directed by the U. S. State Department on the possibility that some of the oil might reach North Korea. The British issued similar orders affecting Shell, reversing their earlier position the Chinese exports were sufficient for civilian consumption only.

XUM

New Job

Kygar elected president of Continental Pipe Line

W. L. KYGAR, Ponca City, Okla., has been elected president of Continental Pipe Line Co., and will assume his new duties on August 1.

Associated with Continental Oil Co. for more than 25 years, Kygar formerly served as assistant manager of the company's motor - transportation division, but spent many years in pipe-line and production operations.

Joining Continental Oil Co. in 1926, after graduation from the University of Oklahoma, Kygar first served as a meterman for Ponca City Gas Distributing Co. In 1928 he was transferred to pipe-line accounting, and held various positions in this division, becoming chief clerk in 1930. He was promoted to chief clerk of the production and drilling department in 1935, and in 1936 was named assistant to the manager. He was appointed assistant manager of the production and drilling department east of the Rocky Mountains in May 1943, and was named assistant manager of the motor - transportation in September 1948.

Continental Pipe Line Co. has a system of approximately 2,000 miles of lines in Oklahoma, Texas, Louisiana, New Mexico, Kansas, Indiana, Wyoming, and Montana.

George W. Evans, Houston, manager of Continental Oil Co.'s transportation and purchasing departments, has been elected chairman of the board of directors of Continental Pipe Line Co. **A. C. Wilkinson,** Ponca City, Okla., will continue as vice president and manager of the pipe-line firm.

John A. Sutherland, junior mechanical engineer for Stanolind Oil & Gas Co. at Midwest, Wyo., has been transferred to the Elk Basin gasoline plant near Powell, Wyo.

Nasser Esphahanian has joined American Liberty Oil Co. as junior processing engineer at Mount Pleasant, Tex.

Roy H. Gray, foreman at Poland, Ind., for Gulf Refining Co., has been transferred to Cambridge City, Ind., in that capacity.

Don M. Rounds, district landman at Wichita for The Texas Co., will resign August 1 to become associated with the Fred Demier, Jr., Interests, of Miami, Okla., as manager of producing oil and gas properties.

W. A. Newhoff, vice president of Union Oil Co. and manager of the company's central territory, will retire on August 1, after more than 30 years of service. He will be succeeded by **F. K. Caldwell,** manager of the northwest territory, Seattle. **A. D. Gass** will succeed Caldwell in Seattle.

D. W. SIMS

D. W. Sims, Ponca City, Okla., has been named manager of Continental Oil Co.'s motor - transportation division, assuming operations formerly directed by **W. L. Kygar,** who was elected president of Continental Pipe Line. **John Kelly,** formerly motor-transportation engineer, has been named assistant manager of the division. Sims has been with Continental for more than 20 years, and formerly was assistant manager of the pipe-line department. Kelly joined the company in 1946, serving in the production department.

James S. Moulton, vice president and executive engineer for Pacific Gas & Electric Co., San Francisco, has been named chairman of American Gas Association's Distinguished Service Award committee. Other members are: **R. L. Fletcher,** president, Providence Gas Co., Providence, R. I.; **S. B. Irelan,** president, Cities Service Gas Co., Oklahoma City; and **Kurwin R. Boyes,** secretary, A.G.A., who will serve as committee secretary.

B. G. Kegley, vice president and drilling superintendent of Signal Drilling Co., has transferred from Great Bend, Kans., to the Sussex pool in Johnson County, Wyoming, where he is serving as drilling superintendent.

W. J. Palk, natural-gasoline-plant foreman at Sivells Bend, Tex., for Standard Oil Co. of Texas, has been transferred to the North Snyder, Tex., plant in that capacity.

Billy E. New, tool pusher at Eunice, N. M., for Parker Drilling Co., has been transferred to Roswell, N. M., in the same capacity.

Floyd C. Ramsey has announced dissolution of Ramsey Petroleum Co., and has moved his office from El Dorado, Kans., to Dallas.

John H. Maxson, formerly Rocky Mountain division geologist for Anderson-Prichard Oil Corp., has established offices in Denver, specializing in photography and petroleum geology.

Ivor L. Mock, assistant district gager at Ellinwood, Kans., for Kaw Pipe Line Co., has been transferred to Lyons, Kans., as delivery gager.

W. O. Keller, Fort Worth, has resigned as reservoir engineering supervisor for Stanolind Oil & Gas Co., to become affiliated with **L. F. Peterson,** consultant, in the firm of Keller & Peterson.

H. O. Evinger has been named superintendent of Sun Oil Co.'s Sun field natural-gasoline plant in Starr County, Texas. He succeeds **Roy L. Cochran** who has been transferred to Brookhaven, Miss., on a special assignment. **John Shimer** is the new superintendent at the Jameson natural-gasoline plant in Coke County, Texas, succeeding Evinger.

***SERVICE EMBLEM.**—O. C. Schorp, Tulsa, left, president of Carter Oil Co., receives a 30-year service emblem from John W. Brice, New York City, director of Standard Oil Co. (N. J.), parent company of Carter. John R. Suman, New York City, Jersey Standard vice president and director, looks on.*

HOUSTON NOMADS VISITORS.—Foreign and domestic visitors who attended the recent Houston Chapter of Nomads meeting are, front row, left to right: Roberto Abila, Socony-Vacuum Oil Co., Inc., Bogota, Colombia; H. E. McAfee, Colombian Petroleum Co.; W. H. Siems, Hughes Tool Co., New York; T. R. Bibee, Gulf Oil Corp., Houston; Francis G. West, Asiatic Petroleum Corp., Houston; and W. H. Larkin, Larkin Packer Co., St. Louis. Back row, left to right: Walter Ervin, Petroleos Mexicanos, Mexico City; P. N. Linton, N. V. De Bataafsche Petroleum Maatschappij, The Hague, the Netherlands; R. S. Peterson and K. E. Waggener, Shaffer Tool Works, Brea, Calif.; and Alexander Goldie, Brunin, Borneo.

S. F. Heard, president and managing director of Royalite Oil Co., Ltd., Calgary, Alta., Canada, has retired

S. F. HEARD

C. U. DANIELS

from the company, and has been succeeded by **C. U. Daniels,** who also will be a member of the board of directors. Heard, a director of Royalite since 1936, and president and managing director since 1947, has had 30 years of active service. Daniels, who took over his new duties July 15, has had 38 years' experience in the oil and natural-gas industries, having spent considerable time in Venezuela. He started his oil-industry career with Gulf Pipe Line Co. in 1912. He served as president of Pantapec Oil Co. of Venezuela, and Albercan Oil Corp. before being named to his present position.

A. W. Bourne, Jr., a director of Standard-Vacuum Oil Co. for the last 3 years, has been elected a director of the company. He has 35 years' experience in the oil business, mostly in marketing in the Far East. After repatriation from Hong Kong in 1942, he handled postwar planning for the company in New York. He returned to Shanghai as general manager in 1945 and was brought back to New York as a director in 1947.

Edward S. Parker, superintendent of oil movement and storage, grease manufacturing, packaging, and shipping at Esso Standard Oil Co.'s Baltimore refinery, recently rounded out 50 years of service at that plant.

Stewart P. King, formerly vice president in charge of operations for Franco Oils, Ltd., has been elected president of Albercan Oil Corp. He succeeds **C. U. Daniels,** who has become president of Royalite Oil Co., Ltd. **William F. Smith II** has been named vice president of Albercan. King, a native of Calgary, worked in producing operations in Trinidad before becoming a district petroleum engineer with Creole Petroleum Corp. in Venezuela in 1944. He returned to Canada in 1948 to join the Franco Oils organization.

S. P. KING

H. G. Walter, district geologist in the Appalachian area for Ohio Oil Co., with headquarters at Terre Haute, Ind., has been transferred to Billings, Mont., where he will serve as geologist for the Dakotas and Montana.

N. W. Freeman, formerly assistant to the president of Tennessee Gas Transmission Co., Houston, has been elected a vice president of the company. Also elected to that position were: **R. L. McVey,** formerly controller; **Harold Burrow,** formerly manager of the gas-supply department; and **Louis Sonnen,** formerly manager of the purchasing department. Freeman, Burrow, and Sonen joined T.G.T. during its formative stages in 1943, and McVey came with the company in 1945. Freeman, formerly manager of the personnel department, became assistant to the president in 1947. McVey began as assistant to the vice president, and was named controller in 1947. Burrow first served as purchasing agent, and later was named manager of the gas-supply department. Sonnen began in the purchasing department, and was named its head in 1949.

HAROLD BURROW

G. D. Goodwin, field production superintendent for Union Producing Co. at Vivian, La., has been transferred to the Big Island field as field superintendent.

Frank Roberson, Coushatta, La., has been elected president of the Butane-Propane Institute of Louisiana. Others elected include: **E. R. McCormick,** Oak

XUM

PERSONALS

Grove, La., vice president; **Howard Pecot,** New Iberia, La., secretary; and **Victor LaGrance,** Lake Charles, La., treasurer.

G. G. Oberfell, member of the board of directors and the executive committee of Phillips Petroleum Co., Bartlesville, Okla., and vice president of research and development, will retire on August 1, after more than 25 years' service with the company. Changes brought about by his retirement include the following: **B. F. Stradley,** secretary-treasurer for several years, has been elected a member of the board and the executive committee, and was named vice president and treasurer; **R. W. Thomas,** manager, research and development, was elected vice president of research and development, and will supervise all research and patent activities as well as chemical manufacturing, development, and sales; and **Paul J. Parker,** assistant secretary and assistant treasurer, was elected secretary and assistant treasurer. Thomas started in the engineering department in 1926, and Parker joined the company as attorney in 1936.

G. G. OBERFELL

John A. Barnett, Jr., has resigned as geologist for Seaboard Oil Co. of Delaware, at Abilene, Tex., to become associated with his father as an independent geologist. He has been succeeded at Seaboard by **John Skelly** who transferred to Abilene from the company's Dallas office.

J. C. Richdale, manager of New England sales division, Esso Standard Oil Co., has been appointed assistant to **Stanley C. Hope,** Esso president, with headquarters in Boston. He is succeeded by **B. F. Shea,** former assistant division manager.

Earl Bartholomew, general manager, Research Laboratories, Ethyl Corp., will represent the Society of Automotive Engineers on the United States national committee which has been organized to assist with the Third World Petroleum Congress, to be held at The Hague, the Netherlands, May 28-June 6. Other members include: **J. E. Brantly,** president, Drilling & Exploration Co., Inc.; **F. E. Clulow,** vice president, Shell Oil Co.; **Dr. W. F. Faragher,** Houdry Process Corp.; **Dr. Paul D. Foote,** vice president, Gulf Research & Development Co.; **A. P. Frame,** president, Cities Service Research & Development Co.; **J. R. Keith,** manager, research and development, Caltex-Bahrein Group; **C. G. Kirkbride,** Houdry Process Corp., representing American Institute of Chemical Engineers; **Dr. E. V. Murphree,** president, Standard Oil Development Co.; **Dr. L. L. Nettleton,** Gravity Meter Exploration Co., representing Society of Exploration Geophysicists; **C. E. Reistle, Jr.,** director of production, Humble Oil & Refining Co., representing the American Institute of Mining and Metallurgical Engineers; and **Dr. M. E. Spaght,** president, Shell Development Co.

M. H. Guess has been transferred from Midland, Tex., to Elk City, Okla., as assistant production superintendent for Shell Oil Co.

Wilburn Seals has been named assistant to the area geologist of Continental Oil Co. at Fort Worth, succeeding **Hal Bybee,** who transferred to Abilene, Tex., as division geologist. Seals formerly was with Tide Water Associated Oil Co.

O. B. Jordan has been transferred from Magnolia Petroleum Co.'s Falfurrias, Tex., producing district, where he was assistant production superintendent, to Snyder, Tex., as assistant superintendent of the Brownfield, Tex., district.

W. C. Whaley, newly elected director of Sunray Oil Corp., who will head West Coast operations for the company, has announced the following assignments: Producing properties in the Santa Maria Valley area and other partnership operations in the Los Angeles Basin will be under the direction of **Floyd L. Martin,** director, vice president, and manager of the refining division at Tulsa. Supervising personnel for Sunray's West Coast operations will be directed by **W. A. Fueller,** manager, land department. Field supervision has been announced as follows: **O. A. Graybeal,** reservoir engineer; **T. J. Prehoda,** drilling superintendent; **D. L. Caldwell,** drilling-department engineer; **F. W. Borden,** production superintendent; **T. H. Acres,** engineer; **M. C. Welch,** superintendent, gas and gasoline department; and **E. B. Closson,** superintendent, mechanical department.

Prentice F. Brown, formerly in charge of Honolulu Oil Corp.'s operations in Texas, has resigned as vice president and director of the company and will enter business for himself. He had been associated with Honolulu for 23 years.

DEATHS

John McLenahan Crawford, 83, founder of Parkersburg Rig & Reel Co. and chairman of its board of directors, died July 20 in Parkersburg, W. Va. Crawford, who was said to be the oldest active member in point of service in the American petroleum industry, started his firm in 1897. Prior to that he worked for various oil companies, including North Fork Oil Co. of Illinois, Sperry Oil & Gas Co., and Oklahoma Producing Co. of New York. He was a director of the American Petroleum Institute and Consolidated Natural Gas Co. in later years. He played an important part in development of many of the now-famous oil fields in the Mid-Continent area and the Southwest, and helped pioneer and found the refining industry in those areas. A native of Limavdy, County Derry, Ireland, Crawford came to America in 1883, settling in Bradford, Pa. In addition to his activities in the oil and gas industries, Crawford was prominent in public service, having served at various times on the Governor's Staff of West Virginia, a director of the United States Chamber of Commerce, and the West Virginia State Tax Commission.

Warren D. Smith, 70, geologist and head of the University of Oregon's geological department from 1914 to 1947, died July 17 at Eugene, Ore.

John M. Cullens, 64, organizer and president of Buda Engine Sales & Service, Inc., died at Hempstead, L. I., N. Y., July 23.

William G. Helis, Sr., 63, New Orleans oil producer and wildcatter, died in Baltimore July 25. Well known in the oil industry, he discovered several major oil fields in South Louisiana. Helis was a native of Greece and came to the United States at the age of 17.

XUM

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MIDYEAR ECONOMICS AND ENGINEERING REPORT

THE OIL AND GAS JOURNAL

DRILLING for last half is forecast at 22,826 wells totaling 84,493,000 ft. compared with 20,258 wells and 74,816,000 ft. in first half. Big gains are predicted for operating rotary rigs.

WILDCAT COMPLETIONS will set new record in last half, 4,391 wells compared with 3,827 in first 6 months.

PRODUCTION in United States will be up about 4.5 per cent for the year. Foreign production was up 13.6 per cent for first half.

DEMAND for crude and products in last half will average 6,633,500 bbl. daily, up 6.1 per cent from last year.

REFINING operations will reach new peak in last half. National lube capacity is at all-time high.

NATURAL-GAS sales by utilities set new record in first half. Continued expansion is expected.

LIGHT-HYDROCARBON production for first 4 months was up 14.1 per cent over same months in 1949.

PIPE LINES dominate industry construction with 9,000 miles under way throughout the world. Additions to cracking capacity at refineries amounts to 120,000 bbl. daily. Natural-gasoline plant capacity gains 1,000,000,000 cu. ft. daily.

IMPORTS were up 221,000 bbl. daily for first 5 months.

And

ENGINEERING REFERENCE SECTION.—Included here in pages 216 to 322 are a selected group of authoritative reference articles, on refining and petrochemistry, drilling, production, pipe lines, and natural gas.

XUM

OPERATORS FORESEE NEW ALL-TIME DRILLING RECORD

By JOHN C. CASPER

Operators say they will set a new all-time drilling record in the last half of the year.

Total completions are forecast at 22,826 wells, up 2,582 from last half of 1949.

The hunt for new oil calls for 4,391 wildcats, a gain of 640 over same period last year.

Drillers will make 84,493,000 ft. of hole, more than annual totals for years 1942, 1943, or 1944.

Projected total completions represent an increase of 12.8 per cent over first half.

OPERATORS plan to drill more wells in the last 6 months of this year than in any half-year period in history. The forecast for the last half, based on company replies to The Oil and Gas Journal's semi-annual drilling survey, includes 4,391 wildcat completions and 18,435 development wells for a total of 22,826 wells with 84,493,000 ft. of hole.

Replies were from all types of operators, ranging from those who plan to drill only one well in the last half to large companies with hundreds of wells scheduled. Out of the total, 61.1 per cent of the companies or individual operators reported more completions projected for the last half than actual completions in the first half, while 11.9 per cent had drilling programs calling for completions at the first-half rate. Only 27 per cent indicated a reduction in the number of wells scheduled for the last half.

Drilling plans for the last half represent an increase of 12.7 per cent over total completions in the first half. This is larger than the percentage gain for comparable periods in the previous record year of 1948.

However, it should be noted that it is normal for the last half of the year to have more completions than the first. The last half has 3 more days and this factor accounts for almost 400 wells in this year's forecast. Also, drilling in the last half is affected less by bad weather and has the advantage

Table 1—Drilling Program—Last Half of 1950

	Forecast last half 1950				Change from last half 1949			
	Wildcat wells	Field wells	Total wells	Total footage (thou. ft.)	Wildcat wells	Field wells	Total wells	Total footage (thou. ft.)
Alabama	10	9	19	74	+ 2	+ 4	+ 6	+ 13
Arkansas	58	161	219	715	+ 12	+ 31	+ 43	+ 51
California	280	695	975	4,406	+ 62	— 254	— 192	— 623
Colorado	18	22	40	158	— 14	+ 8	— 6	— 31
Illinois	443	877	1,320	2,950	+ 21	— 235	— 214	— 427
Indiana	317	494	811	1,435	+ 65	+ 45	+ 110	+ 189
Kansas	404	1,810	2,214	6,969	+128	+ 185	+ 313	+1,065
Kentucky	118	503	621	1,158	+ 3	— 2	+ 1	+ 67
Louisiana	138	1,275	1,413	8,455	— 1	+ 56	+ 55	+1,774
North	33	709	742	2,629	— 27	— 141	— 168	— 94
South	105	566	671	5,826	+ 26	+ 197	+ 223	+1,868
Michigan	173	274	447	1,113	— 2	— 101	— 103	— 113
Mississippi	70	145	215	1,632	+ 13	+ 46	+ 59	+ 533
Montana	24	102	126	321	— 2	— 20	— 22	— 18
Nebraska	29	22	51	200	+ 18	+ 13	+ 31	+ 125
New Mexico	66	295	361	1,836	+ 24	+ 107	+ 131	+ 682
New York	0	452	452	649	...	+ 41	+ 41	+ 64
Ohio	19	523	542	1,186	+ 4	— 22	— 18	+ 102
Oklahoma	497	2,451	2,948	10,393	+ 84	+ 562	+ 646	+2,421
Pennsylvania	3	872	875	1,574	— 1	+ 19	+ 18	+ 236
Texas	1,613	6,841	8,454	36,655	+263	+1,376	+1,639	+8,579
North Central	583	1,907	2,490	7,343	+ 62	+ 112	+ 174	+ 871
West	367	2,165	2,532	13,750	+190	+ 666	+ 856	+5,461
Panhandle	16	495	511	1,608	+ 7	+ 56	+ 63	+ 204
Eastern	114	517	631	2,519	+ 10	+ 99	+ 109	+ 179
Gulf Coast	249	951	1,200	6,825	+ 1	+ 198	+ 199	+1,059
Southwest	284	806	1,090	4,610	— 7	+ 245	+ 238	+ 805
Utah	8	6	14	79	— 6	— 8	— 14	— 72
West Virginia	20	353	373	970	+ 9	+ 85	+ 94	+ 206
Wyoming	73	229	302	1,500	— 2	— 6	— 8	— 2
Miscellaneous	10	24	34	65	— 40	+ 12	— 28	— 103
Total United States	4,391	18,435	22,826	84,493	+640	+1,942	+2,582	+14,718

TABLE 2—DRILLING IN 1950 BY TYPE OF OPERATOR

	34 large operators	All other operators	Total industry
First half actual—			
Wildcats	483	3,354	3,837
Field wells	4,100	12,321	16,421
Total	4,583	15,675	20,258
Last half forecast—			
Wildcats	687	3,704	4,391
Field wells	4,477	13,958	18,435
Total	5,164	17,662	22,826
Per cent increase (last half vs. first half)—			
Wildcats	+42.2	+10.4	+14.4
Field wells	+ 9.2	+13.3	+12.3
Total	+12.6	+12.7	+12.7

TABLE 3—RATIO OF WILDCAT DRILLING TO TOTAL
(Per cent)

	Last half 1950 (forecast)	First half 1950 (actual)	Last half 1949 (actual)
Arkansas	26.4	25.9	26.1
California	28.7	24.8	18.7
Colorado	45.0	71.4	69.6
Illinois	33.6	30.1	27.5
Indiana	39.0	36.1	35.9
Kansas	18.2	19.2	14.5
Kentucky	19.0	17.5	18.5
Louisiana	9.8	11.4	10.2
North	4.4	7.4	6.6
South	15.6	15.6	17.8
Michigan	38.7	34.2	31.8
Mississippi	32.5	39.6	36.5
Montana	19.0	14.5	17.6
Nebraska	56.9	53.3	55.0
New Mexico	18.3	10.5	18.3
Oklahoma	16.9	16.1	17.9
Texas	19.1	19.6	19.8
North Central	23.4	24.1	22.5
West	14.5	13.0	10.6
Panhandle	3.1	2.9	2.0
East	18.1	19.1	19.9
Gulf	20.7	21.4	24.8
Southwest	26.0	30.0	34.2
Wyoming	24.2	14.5	24.2
Eastern and other	3.0	3.6	4.6
Total	19.2	18.9	18.5

of any general long-term upward trend in the search for oil.

Total completions in the first 6 months represented an all-time record for the first half of the year, and this total combined with the forecast for the last half places 1950 well out in front of all other years. The revised forecast for the year now stands at 43,084 wells compared with 39,038 in 1949 and 39,778 in 1948.

There are several special factors affecting drilling for the last half of this year. Crude prices have always influenced drilling, and all trends are toward a firm crude market for the remaining months of the year. The increase in refinery realization from a barrel of crude has removed most of the pressure for lower crude prices.

All published forecasts of demand indicate new record levels for next winter. Crude and product stocks have been depleted and must be replenished before cold weather. This calls for increased crude production. The combination of firm crude markets and prospects for increased production promotes drilling.

In normal times the high ratio of reserves would tend to retard drilling activity but the possibility of having to oil another all-out war has overshadowed the postwar gain in reserves. The much-discussed

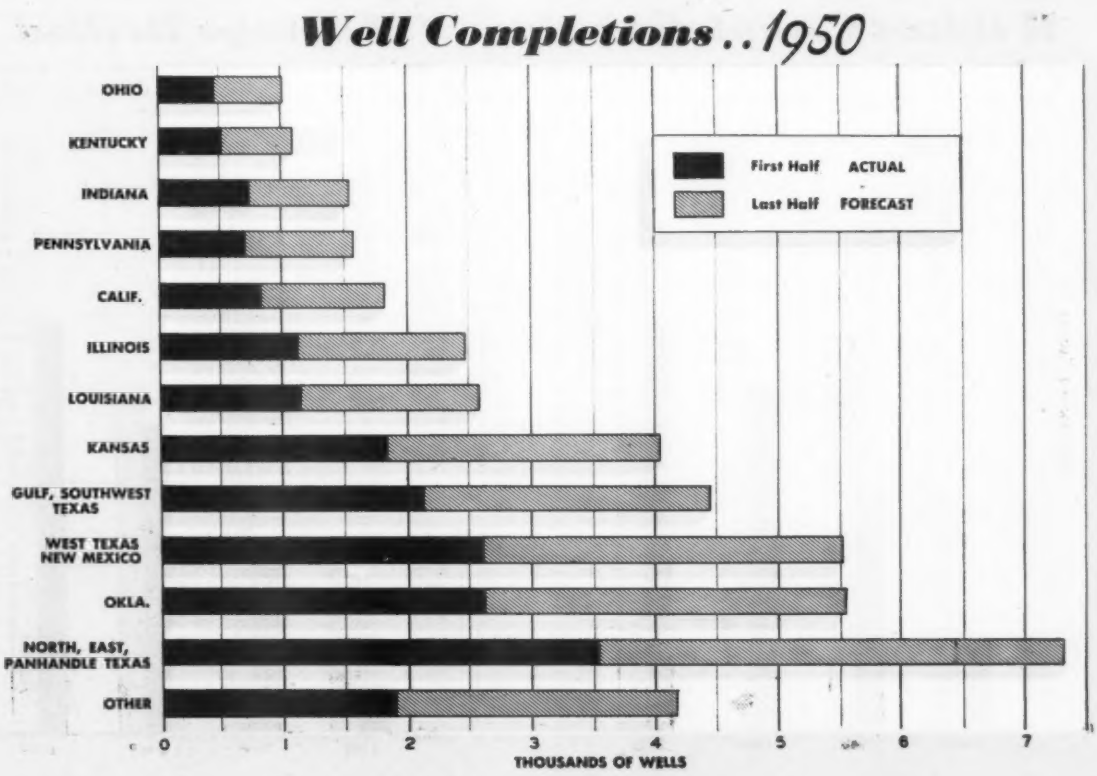


TABLE 4—AREAS WITH OVER THREE MILLION FEET SCHEDULED
(Thousands of feet)

	Last half 1950 (forecast)	First half 1950 (actual)	Last half 1949 (actual)
West Texas	13,750	12,305	8,289
Oklahoma	10,393	9,244	7,972
Louisiana	8,455	7,186	6,681
North Central Texas	7,343	7,185	6,472
Kansas	6,969	5,914	5,904
Gulf Coast Texas	6,825	6,477	5,766
Southwest Texas	4,610	4,500	3,805
California	4,406	3,699	5,029
Subtotal	62,751	56,510	49,918
All other areas	21,742	18,306	19,857
Total United States	84,493	74,816	69,775

TABLE 5—AREAS WITH OVER 1,000 WELLS SCHEDULED

	Last half 1950 (forecast)	First half 1950 (actual)	Last half 1949 (actual)
Oklahoma	2,948	2,622	2,302
West Texas	2,532	2,302	1,676
North Central Texas	2,490	2,445	2,316
Kansas	2,214	1,852	1,901
Louisiana	1,413	1,187	1,358
Illinois	1,320	1,169	1,534
Gulf Coast Texas	1,200	1,111	1,001
Southwest Texas	1,090	1,025	852
Subtotal	15,207	13,693	12,940
All other areas	7,619	6,565	7,304
Total United States	22,826	20,258	20,244

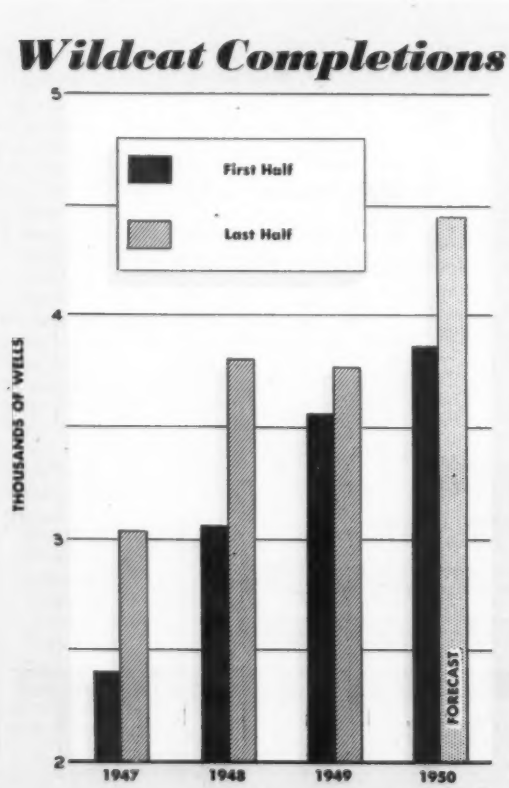
shut-in production which amounted to about 1,000,000 bbl. daily last year, is shrinking both actually as current production is increased and relatively in comparison with the oil needs for total war.

The drilling forecast for the last 6 months of the year is based on operating schedules set up at the beginning of the period. Industrial readjustments, brought about by war conditions, could change these plans. Abnormal steel shortages during the period would reduce total completions. Steel at present is tight, but if it is competitively available for the remainder of the year, the possibility of use restrictions in 1951 may cause some companies to step up drilling activity in the last half of this year to include some wells scheduled for 1951.

The search for new oil calls for 4,391 wildcat completions in the last half, another new record in the upward trend of exploratory drilling. Completions in the first 6 months had set a new half-year record, and operators say they will drill 14.4 per cent more wildcats in the last half. If this objective is reached, a total of 8,228 wildcats will be drilled this year, an increase of 150 per cent over 1941 compared with a gain of 34 per cent in total completions.

Successful wildcatting is followed by expanded development programs. Many companies are now drilling up and expanding new fields and new pays discovered in 1949 or in the first half of this year. This development program calls for the completion of 18,435 field wells in the last half of the year, a gain of 12.3 per cent over the first half and 11.7 per cent over the last 6 months of 1949. The forecast of field-well completions includes service wells for repressuring, water flooding, and salt-water disposal in addition to those drilled for oil and gas.

Total development drilling for the year is forecast at 34,856 wells compared with 31,744 in 1949 and 32,901 in 1948.



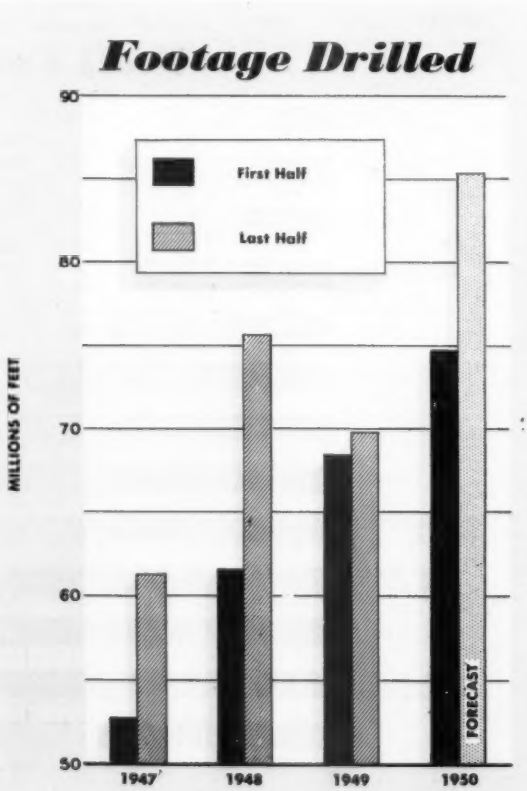


TABLE 6—LAST HALF 1950 (FORECAST) VS. FIRST HALF 1950 (ACTUAL)

	Total footage (thou. ft.)			Total wells			Wildcat wells			Development wells		
	Last half (forecast)	First half (actual)	Change	Last half (forecast)	First half (actual)	Change	Last half (forecast)	First half (actual)	Change	Last half (forecast)	First half (actual)	Change
Alabama	74	69	+ 5	19	18	+ 1	10	10	.....	9	8	+ 1
Arkansas	715	629	+ 86	219	193	+ 26	58	50	+ 8	161	143	+ 18
California	4,406	3,699	+ 707	975	829	+ 146	280	206	+ 74	695	623	+ 72
Colorado	158	72	+ 86	40	21	+ 19	18	15	+ 3	22	6	+ 16
Illinois	2,950	2,561	+ 389	1,320	1,169	+ 151	443	352	+ 91	877	817	+ 60
Indiana	1,435	1,278	+ 157	811	742	+ 69	317	268	+ 49	494	474	+ 20
Kansas	6,969	3,914	[illegible]	2,214	1,832	+ 382	404	351	+ 53	1,810	1,481	+ 329
Kentucky	1,158	895	+ 263	621	513	+ 108	118	90	+ 28	503	423	+ 80
Louisiana	8,455	7,186	+1,269	1,413	1,187	+ 226	138	135	+ 3	1,275	1,052	+ 223
North	2,629	2,181	+ 448	742	618	+ 124	33	46	— 13	709	572	+ 137
South	5,826	5,005	+ 821	671	569	+ 102	105	89	+ 16	566	480	+ 86
Michigan	1,113	894	+ 219	447	389	+ 58	173	133	+ 40	274	256	+ 18
Mississippi	1,632	1,218	+ 414	215	169	+ 46	70	67	+ 3	145	102	+ 43
Montana	321	163	+ 158	126	83	+ 43	24	12	+ 12	102	71	+ 31
Nebraska	200	169	+ 31	51	45	+ 6	29	24	+ 5	22	21	+ 1
New Mexico	1,836	1,413	+ 423	361	314	+ 47	66	38	+ 28	295	276	+ 19
New York	649	468	+ 181	452	326	+ 126	0	0	0	452	326	+ 126
Ohio	1,186	1,036	+ 150	542	474	+ 68	19	9	+ 10	523	465	+ 58
Oklahoma	10,393	9,244	+1,149	2,948	2,622	+ 326	497	423	+ 74	2,451	2,199	+ 252
Pennsylvania	1,574	1,263	+ 311	875	723	+ 152	3	2	+ 1	872	721	+ 151
Texas	36,655	34,360	+2,295	8,454	7,964	+ 490	1,613	1,564	+ 49	6,841	6,400	+ 441
North Central	7,343	7,185	+ 158	2,490	2,445	+ 45	583	589	— 6	1,907	1,856	+ 51
West	13,750	12,305	+1,445	2,532	2,302	+ 230	367	300	+ 67	2,165	2,002	+ 163
Panhandle	1,608	1,508	+ 100	511	475	+ 36	16	14	+ 2	495	461	+ 34
Eastern	2,519	2,385	+ 134	631	606	+ 25	114	116	— 2	517	490	+ 27
Gulf Coast	6,825	6,477	+ 348	1,200	1,111	+ 89	249	238	+ 11	951	873	+ 78
Southwest	4,610	4,500	+ 110	1,090	1,025	+ 65	284	307	— 23	806	718	+ 88
Utah	79	32	+ 47	14	8	+ 6	8	3	+ 5	6	5	+ 1
West Virginia	970	794	+ 176	373	321	+ 52	20	22	— 2	353	299	+ 54
Wyoming	1,500	1,337	+ 163	302	269	+ 33	73	39	+ 34	229	230	— 1
Miscellaneous	65	122	— 57	34	47	— 13	10	24	— 14	24	23	+ 1
Total United States	84,493	74,816	+9,677	22,826	20,258	+2,568	4,391	3,837	+554	18,435	16,421	+2,014

The drilling program for the last half calls for 84,493,000 ft. of hole, representing an increase of 12.9 per cent over the total for the first half. Since this is slightly larger than the percentage increase in total completions, it indicates a small gain in average well depth.

The forecast by states is shown in Table 1, including comparisons with actual data for the last half of 1949. Comparisons with the first half of 1950 are shown in Table 6, and shifts that have taken place since the original forecast are detailed in Table 7.

TABLE 7—INDUSTRY'S 1950 DRILLING PROGRAM REVISED AT MIDYEAR COMPARED WITH ORIGINAL IN JANUARY

	Total footage (thou. ft.)			Total wells			Wildcat wells			Development wells		
	Revised program	Jan. program	Change	Revised program	Jan. program	Change	Revised program	Jan. program	Change	Revised program	Jan. program	Change
Alabama	143	30	+ 113	37	8	+ 29	20	5	+ 15	17	3	+ 14
Arkansas	1,344	1,110	+ 234	412	276	+ 136	108	66	+ 42	304	210	+ 94
California	8,105	8,930	— 825	1,804	1,985	— 181	486	365	+121	1,318	1,620	— 302
Colorado	230	315	— 85	61	74	— 13	33	50	— 17	28	24	+ 4
Illinois	5,511	5,750	— 239	2,489	2,517	— 28	795	867	— 72	1,694	1,650	+ 44
Indiana	2,713	2,357	+ 356	1,553	1,275	+ 278	585	432	+153	968	843	+ 125
Kansas	12,883	10,100	+ 2,783	4,046	3,043	+1,003	755	458	+297	3,291	2,585	+ 706
Kentucky	2,053	2,340	— 287	1,134	1,376	— 242	208	200	+ 8	926	1,176	— 250
Louisiana	15,641	14,500	+ 1,141	2,600	2,617	— 17	273	291	— 18	2,327	2,326	+ 1
North	4,810	5,400	— 590	1,360	1,584	— 224	79	108	— 29	1,281	1,476	— 195
South	10,831	9,100	+ 1,731	1,240	1,033	+ 207	194	183	+ 11	1,046	850	+ 196
Michigan	2,007	1,890	+ 117	836	780	+ 56	306	295	+ 11	530	485	+ 45
Mississippi	2,850	2,160	+ 690	384	300	+ 84	137	131	+ 6	247	169	+ 78
Montana	484	525	— 41	209	217	— 8	36	42	— 6	173	175	— 2
Nebraska	369	160	+ 209	96	40	+ 56	53	24	+ 29	43	16	+ 27
New Mexico	3,249	2,900	+ 349	675	581	+ 94	104	119	— 15	571	462	+ 109
New York	1,117	1,045	+ 72	778	727	+ 51	.....	.....	.....	778	727	+ 51
Ohio	2,222	2,360	— 138	1,016	1,106	— 90	28	37	— 9	988	1,069	— 81
Oklahoma	19,637	13,800	+ 5,837	5,570	3,850	+1,720	920	925	— 5	4,650	2,925	+1,725
Pennsylvania	2,837	2,400	+ 437	1,598	1,555	+ 43	5	25	— 20	1,593	1,530	+ 63
Texas	71,015	61,555	+ 9,460	16,418	13,997	+2,421	3,177	2,822	+355	13,241	11,175	+2,066
North Central	14,528	11,380	+ 3,148	4,935	3,955	+ 980	1,172	965	+207	3,763	2,990	+ 773
West	28,055	21,150	+ 4,905	4,834	4,070	+ 764	667	564	+103	4,167	3,506	+ 661
Panhandle	3,116	3,210	— 94	986	1,037	— 51	30	7	+ 23	956	1,030	— 74
Eastern	4,904	4,200	+ 704	1,237	865	+ 372	230	118	+112	1,007	747	+ 260
Gulf Coast	13,302	14,290	— 988	2,311	2,392	— 81	487	565	— 78	1,824	1,827	— 3
Southwest	9,110	7,325	+ 1,785	2,115	1,678	+ 437	591	603	— 12	1,524	1,075	+ 449
Utah	111	210	— 99	22	42	— 20	11	11	.....	11	31	— 20
West Virginia	1,764	1,520	+ 244	694	521	+ 173	42	36	+ 6	652	485	+ 167
Wyoming	2,837	2,410	+ 427	571	511	+ 60	112	82	+ 30	459	429	+ 30
Miscellaneous	187	111	+ 76	81	16	+ 65	34	13	+ 21	47	3	+ 44
Total United States	159,309	138,478	+20,831	43,084	37,414	+5,670	8,228	7,296	+932	34,856	30,118	+4,738

XUM

20,258 WELLS FINALED FIRST HALF TO SET NEW ALL-TIME PEAK

By POLLY DE ARMOND

THE answer to expected unprecedented requirements for crude and its products has been a record-breaking drilling campaign the first half of this year. The greater the demand, the higher the rate of withdrawals from proven production, necessitating increases in net reserves. To keep pace with this situation, operators completed 20,258 wells up to July 1. This total number established a new all-time peak for any comparable period, and represented an increase of 1,464 completions (7.8 per cent) over the previous record set during the first 6 months of last year. A favorable success ratio has been maintained in this all-out expansion program; excluding 583 service wells, 13,048 (66.3 per cent) of the searches found oil or gas production.

Total footage reached 74,816,448 ft., also a new high and a gain of 6,588,199 ft. (9.7 per cent) over the same months of 1949. Average depth for the period was 3,693 ft. per well, compared with 3,630 ft. the previous year, due to the continued decline in activity in the shallow Eastern area coupled with accelerated drilling in deeper sections, particularly the Mid-Continent.

Extensive exploration and development of the reef areas in West Texas, accent on operations in some of the deeper Wyoming fields (Church Buttes, Cole Creek, Riverton, Sussex, and Worland, for example), and several completions over 12,500 ft. (notably in and around Ventura Avenue field in California), are the principal reasons for the over-all average footage-per-well increase, despite the fact that most of the states reported declines in this figure.

Average depths for individual states are as follows: Alabama, 3,856 ft.; Arkansas, 3,260 ft.; California, 4,463 ft.; Colorado, 3,428 ft.; Florida, 6,016 ft.; Illinois, 2,190 ft.; Indiana, 1,723 ft.; Kansas, 3,228 ft.; Kentucky, 1,744 ft.; Louisiana, 5,695 ft.; Michigan, 2,298 ft.; Mississippi, 7,205 ft.; Montana, 1,966 ft.; Nebraska, 3,759 ft.; New Mexico, 4,499 ft.; New York, 1,436 ft.; Ohio, 2,185 ft.; Oklahoma, 3,526 ft.; Pennsylvania, 1,747 ft.; Texas, 4,314 ft.; Utah, 3,956 ft.; West Virginia, 2,473 ft.; Wyoming, 4,970 ft.; miscellaneous, 1,428 ft.

Summary of Completed Wells, First 6 Months, 1950

	Total comp.	Oil	Gas	Dry	Service	Footage (thou. ft.)	Total Jan.-June 1949
Alabama	18	5	1	12	0	69	6
Arkansas	193	114	0	79	0	629	146
California	829	583	14	232	0	3,699	1,345
Colorado	21	2	2	17	0	72	36
Florida	11	1	0	10	0	66	13
Illinois	1,169	549	5	615	0	2,561	1,117
Indiana	742	287	18	435	2	1,278	578
Kansas	1,832	932	159	712	29	5,914	1,486
Kentucky	513	241	74	195	3	895	427
Louisiana	1,187	769	103	312	3	7,186	1,013
North	618	383	82	150	3	2,181	538
South	569	386	21	162	0	5,005	475
Michigan	389	172	6	188	23	894	445
Mississippi	169	74	5	90	0	1,218	178
Montana	83	47	8	28	0	163	131
Nebraska	45	15	5	25	0	169	7
New Mexico	314	213	42	59	0	1,413	271
New York	326	166	0	0	160	468	471
Ohio	474	165	135	155	19	1,036	524
Oklahoma	2,622	1,587	128	849	58	9,244	2,050
Pennsylvania	723	344	111	23	245	1,263	1,063
Texas	7,964	5,163	339	2,421	41	34,360	6,850
Eastern (5, 6, 6-P)	606	423	25	150	8	2,385	592
North Central (7-B, 9)	2,445	1,261	40	1,117	27	7,185	2,168
Panhandle (10)	475	315	120	40	0	1,508	511
West (7-C, 8)	2,302	1,927	6	366	3	12,305	1,585
Southwest (1, 4)	1,025	544	69	410	2	4,500	1,015
Gulf Coast (2, 3)	1,111	693	79	338	1	6,477	979
Utah	8	4	0	4	0	32	21
West Virginia	321	86	168	67	0	794	239
Wyoming	269	186	8	75	0	1,337	277
Miscellaneous	36	2	10	24	0	56	40
Jan.-June 1950	20,258	11,707	1,341	6,627	583	74,816	
Jan.-June 1949	18,794	10,725	1,312	6,013	744	68,228	

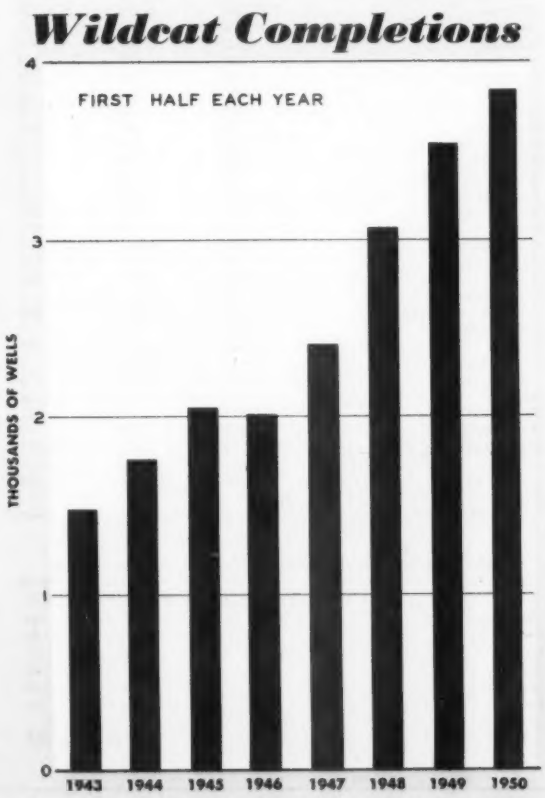
New records were also made in wildcats and their total footage, although the wells drilled were shallower than last year. Completions in this category increased 294 wells (8.3 per cent) and footage was up 735,190 ft. (5 per cent). Average depth was 4,023 ft. per well as against 4,149 ft. in 1949. Almost 18 per cent of the tests were successful, practically no change from last year. It should be noted that this has been a year which saw ventures in some of the remotest untested areas although, so far, the majority of exploratory holes have been "extension" or "new pay" attempts rather than "rank wildcat" tests.

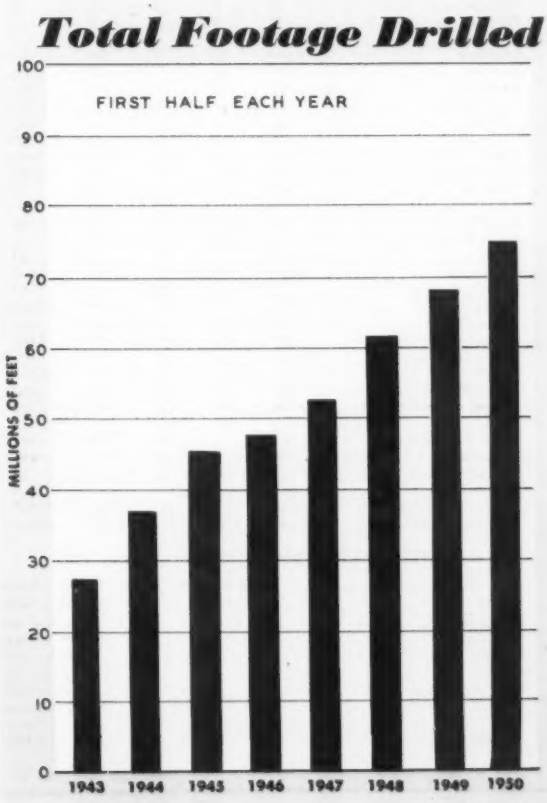
In the January-June comparison with 1949, field completions were up 1,170 wells (7.6 per cent) while footage climbed 5,853,009 ft. (10.9 per cent). Average depth for the period increased this year to 3,616 ft. per well from 3,575 ft. This footage gain reflects the rapid development of newly discovered deeper producing areas.

Ten states accounted for 89.3 per cent of all completions, with the three ranking states remaining in the same order as last year. Texas led the field with 7,964 wells, 39.3 per cent of the total. Oklahoma was next highest with 2,622 completions, or 12.9 per cent. Kansas rated third, reporting 1,832 wells, or 9 per cent. Louisiana, in seventh place last year, jumped to fourth, with 1,187 wells, or 5.8 per cent of the total. Illinois stayed in fifth position, completing 1,169 wells, nearly 5.8 per cent. California dropped from fourth to sixth, noting 829 completions, or 4.1 per cent of all wells. Indiana stepped up from eighth to seventh with 742 wells, or 3.6 per cent. Pennsylvania (723 completions, or 3.5 per cent) fell from sixth to eighth. Kentucky, not in the first 10 last year, placed ninth with 513 wells, or 2.5 per cent of the total. Ohio (474 wells, or 2.4 per cent) slipped from ninth into the tenth spot.

COMPLETIONS BY STATES—DEPTH CLASSIFICATIONS

	Under 2,500 ft.	2,500-5,000 ft.	5,000-7,500 ft.	7,500-10,000 ft.	10,000-12,500 ft.	Over 12,500 ft.
Alabama	3	11	3	1	0	0
Arkansas	50	124	10	9	0	0
California	214	336	159	78	30	12
Colorado	10	5	6	0	0	0
Florida	2	3	3	0	3	0
Illinois	626	543	0	0	0	0
Indiana	618	124	0	0	0	0
Kansas	263	1,556	13	0	0	0
Kentucky	405	105	3	0	0	0
Louisiana	354	170	215	188	231	29
North	348	110	107	36	17	0
South	6	60	108	152	214	29
Michigan	240	148	1	0	0	0
Mississippi	2	6	95	45	21	6
Montana	56	28	1	0	0	0
Nebraska	8	35	2	0	0	0
New Mexico	71	147	40	37	14	5
New York	326	0	0	0	0	0
Ohio	258	214	2	0	0	0
Oklahoma	805	1,281	435	50	49	2
Pennsylvania	628	93	0	2	0	0
Texas	2,161	2,907	2,129	625	129	13
Eastern	148	313	94	49	1	1
North Central	1,188	993	262	2	0	0
Panhandle	18	445	4	4	4	0
West	362	582	1,085	204	58	11
Southwest	314	308	273	111	19	0
Gulf Coast	131	266	411	255	47	1
Utah	1	7	0	0	0	0
West Virginia	203	87	20	1	0	0
Wyoming	19	131	91	20	5	3
Miscellaneous	30	3	3	0	0	0
Total U. S.	7,353	8,072	3,231	1,056	482	64





DEVELOPMENT WELL COMPLETIONS, FIRST 6 MONTHS

	Comp.	Oil	Gas	Dry and service	Footage (thou. ft.)
Alabama	8	4	0	4	27
Arkansas	143	111	0	32	418
California	623	571	12	40	2,907
Colorado	6	2	2	2	26
Florida	3	1	0	2	35
Illinois	817	502	4	311	1,811
Indiana	474	259	17	198	789
Kansas	1,481	886	154	441	4,682
Kentucky	423	227	73	123	714
Louisiana	1,052	731	99	222	5,991
North	572	378	81	113	1,933
South	480	353	18	109	4,058
Michigan	256	158	2	96	591
Mississippi	102	65	5	32	713
Montana	71	46	8	17	137
Nebraska	21	13	3	5	80
New Mexico	276	201	41	34	1,171
New York	326	166	0	160	468
Ohio	465	164	134	167	1,006
Oklahoma	2,199	1,499	119	581	7,859
Pennsylvania	721	344	111	266	1,246
Texas	6,400	4,905	276	1,219	27,054
Eastern	490	412	24	54	1,923
North Central	1,856	1,162	23	671	5,180
Panhandle	461	314	118	29	1,407
West	2,002	1,875	4	123	10,538
Southwest	718	496	50	172	3,162
Gulf Coast	873	646	57	170	4,844
Utah	5	4	0	1	22
West Virginia	299	86	158	55	675
Wyoming	230	179	8	43	1,144
Miscellaneous	20	2	9	9	13
Jan.-June 1950	16,421	11,126	1,235	4,060	59,379
Jan.-June 1949	15,251	10,178	1,215	3,858	53,527

WILDCAT COMPLETIONS, FIRST 6 MONTHS

	Comp.	Oil	Gas	Dry	Footage (thou. ft.)
Alabama	10	1	1	8	42
Arkansas	50	3	0	47	211
California	206	12	2	192	792
Colorado	15	0	0	15	46
Florida	8	0	0	8	31
Illinois	352	47	1	304	750
Indiana	268	28	1	239	489
Kansas	351	46	5	300	1,232
Kentucky	90	14	1	75	181
Louisiana	135	38	4	93	1,195
North	46	5	1	40	248
South	89	33	3	53	947
Michigan	133	14	4	115	303
Mississippi	67	9	0	58	505
Montana	12	1	0	11	26
Nebraska	24	2	2	20	89
New Mexico	38	12	1	25	242
New York	0	0	0	0	0
Ohio	9	1	1	7	30
Oklahoma	423	88	9	326	1,585
Pennsylvania	2	0	0	2	17
Texas	1,564	258	63	1,243	7,306
Eastern	116	11	1	104	462
North Central	589	99	17	473	2,005
Panhandle	14	1	2	11	101
West	300	52	2	246	1,767
Southwest	307	48	19	240	1,338
Gulf Coast	238	47	22	169	1,633
Utah	3	0	0	3	10
West Virginia	22	0	10	12	119
Wyoming	39	7	0	32	193
Miscellaneous	16	0	1	15	43
Jan.-June 1950	3,837	581	106	3,150	15,437
Jan.-June 1949	3,543	547	97	2,899	14,701

SERVICE WELL COMPLETIONS BY MONTHS

	Pennsylvania	New York	Other states	Total U.S.
January	38	30	25	93
February	38	23	27	88
March	37	17	30	84
April	38	28	24	90
May	45	30	34	109
June	49	32	38	119
Total	245	160	178	583

WELL COMPLETIONS BY MONTHS

Wildcat Completions

	Jan.	Feb.	Mar.	Apr.	May	June
Oil	90	78	101	88	107	117
Gas	17	23	17	12	13	24
Dry	419	480	533	549	536	633
Total	526	581	651	649	656	774

Development Completions

Oil	1,691	1,586	1,919	1,811	1,887	2,232
Gas	207	159	211	162	242	254
Dry	629	569	667	633	743	819
Total	2,527	2,314	2,797	2,606	2,872	3,305

Total Completions

Oil	1,781	1,664	2,020	1,899	1,994	2,349
Gas	224	182	228	174	255	278
Dry	1,048	1,049	1,200	1,182	1,279	1,452
Total	3,053	2,895	3,448	3,255	3,528	4,079

By Depth Classifications

Depth (ft.)						
Under 2,500	1,098	1,025	1,206	1,227	1,345	1,452
2,500-5,000	1,235	1,162	1,349	1,253	1,407	1,666
5,000-7,500	447	493	610	543	496	642
7,500-10,000	181	132	202	149	187	205
10,000-12,500	83	71	71	70	84	103
Over 12,500	9	12	10	13	9	11

SUMMARY OF DRILLING METHODS, FIRST 6 MONTHS

	Total comp.	Rotary comp.	Cable comp.
Alabama	18	18	0
Arkansas	193	193	0
California	829	826	3
Colorado	21	9	12
Florida	11	11	0
Illinois	1,169	1,073	96
Indiana	742	633	109
Kansas	1,832	1,528	304
Kentucky	513	389	124
Louisiana	1,187	1,187	0
North	618	618	0
South	569	569	0
Michigan	389	*141	248
Mississippi	169	169	0
Montana	83	79	4
Nebraska	45	37	8
New Mexico	314	*277	37
New York	326	0	326
Ohio	474	0	474
Oklahoma	2,622	2,003	619
Pennsylvania	723	0	723
Texas	7,964	7,624	340
Eastern	606	606	0
North Central	2,445	2,185	260
Panhandle	475	471	4
West	2,302	2,231	71
Southwest	1,025	1,025	0
Gulf Coast	1,111	1,106	5
Utah	8	8	0
West Virginia	321	0	321
Wyoming	269	269	0
Miscellaneous	36	15	21
Total	20,258	16,489	3,769

*Incl. wells drilled by rotary and finished by cable tools.

DISTILLATE WELL COMPLETIONS BY MONTHS

	Texas	Louisiana	Other states	Total U.S.
January	11	21	4	36
February	7	9	10	26
March	14	17	11	42
April	7	12	6	25
May	13	20	9	42
June	18	14	9	41
Total	70	93	49	212

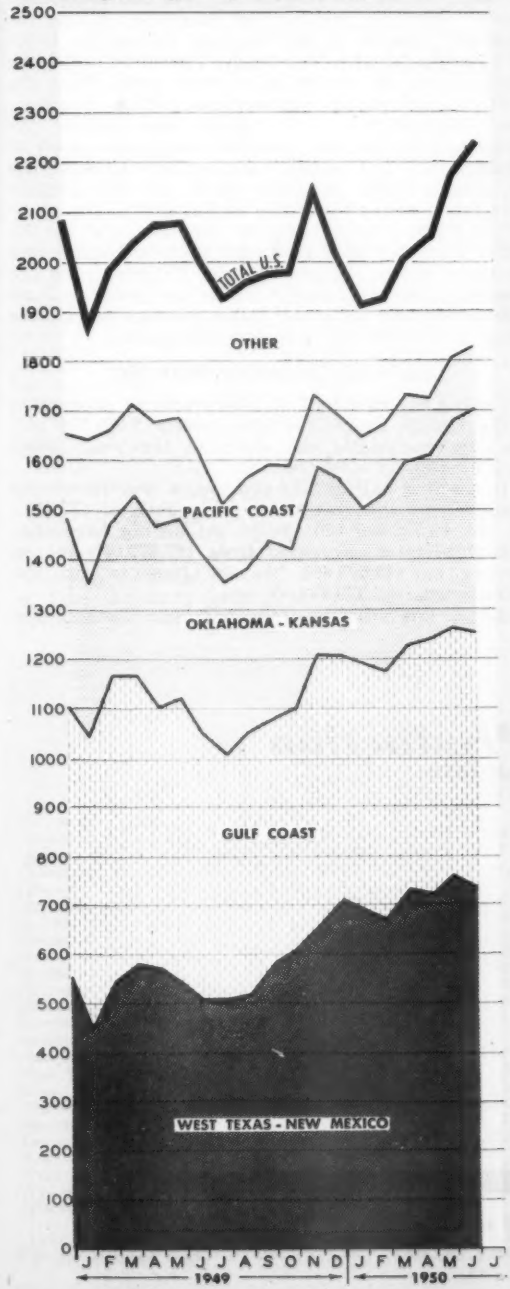
2,329 ROTARY RIGS OPERATING IN U. S., WESTERN CANADA

By NEIL WILLIAMS

MORE rotary drilling rigs were operating in the United States and western Canada at the close of the first half of the year than at any time since the latter part of 1948, when drilling activity was at an all-time high level.

Operating rotary rigs on July 1 totaled 2,329. During the latter part of 1948, in November, the number climbed to a peak of 2,457. At that time exploration for additional petroleum reserves had been greatly stepped up in the face of rapidly mounting oil demand and anticipated shortages.

Rotary Rigs Operating in U. S.



Since then, with more adequate petroleum supplies becoming available and the immediate need for developing new production being less urgent, there has been a substantial recession in efforts in some areas to develop additional reserves.

This was reflected in a sharp decline, partly seasonal, in the total number of operating rigs during the early part of 1949. By February the number had dropped below 1,950. With the coming of spring and more favorable drilling weather and conditions in certain areas, additional rigs found work, and through late spring and summer the number of active rigs ranged between 2,000 and 2,100 most of the time.

Due primarily to the rapidly spreading development and growing drilling activity in the Scurry County area of West Texas, the total number of active rigs rose appreciably later that year, reaching a peak of 2,284 rigs during December.

That peak was passed this year about the middle of June in an upturn in drilling activity that began early in May. Previously, there had been another period of recession in which the number of operating rigs as a whole had declined from the 1949 high mark to a low of under 1,950 rigs in February.

In the midyear upturn in drilling activity, both Oklahoma and the West Texas-New Mexico area exceeded all previous records in their respective numbers of operating rigs. The former state had 313 rigs running on July 1, which was the greatest number in its history. The West Texas-New Mexico high mark of 768 rigs was reported early in June.

Distribution of drilling rigs by area at the July 1 peak of activity as compared with the distribution at the peak of activity in 1946, the year following the close of World War II, and at the peak in 1941, the year prior to the war, is shown in the accompanying tabulation. It will be noted in the comparison that the Gulf Coast, which prior to and through the war led all areas in number of drilling rigs, now ranks second to the West Texas and New Mexico area. The Oklahoma-Kansas area retains its third place position.

DISTRIBUTION OF ACTIVE ROTARY RIGS

(Comparison of Rig Distribution by Areas at July 1 Peak with Distribution at 1946* and 1941* Peaks)

	7-1-1950 Peak		1946 Peak†		1941 Peak†	
	Rigs	Per cent of total	Rigs	Per cent of total	Rigs	Per cent of total
Gulf Coast	522	22.4	495	28.4	378	30.2
W. Tex.-N. M.	730	31.4	417	23.9	283	22.6
Ark.-N. La.-E. Tex.	152	6.5	156	9.0	106	8.5
Okla.-Kans.	448	19.2	299	17.1	180	14.4
Illinois-Eastern	153	6.6	129	7.4	155	12.4
Rocky Mtn.‡	193	8.3	109	6.3	26	2.1
Pacific Coast	131	5.6	138	7.9	122	9.8
Total	2,329	100.0	1,743	100.0	1,260	100.0

*First postwar and first prewar years. †1946 peak in November; 1941 peak in August. ‡Includes western Canada.

XUM

FIRST-HALF PRODUCTION POINTS TO HIGH AVERAGE FOR YEAR

By PHILIP C. INGALLS

CRUDE-OIL production in the United States has been climbing sharply for the past 4 months and it now appears rather certain that the year's production will fall about halfway between last year's total and the all-time record set during 1948.

Daily average production for the first 6 months of 1950 was 5,029,685 bbl., 115,100 bbl. daily less than for the like period in 1949. However, during 1949 the trend was downward during the first 6 months of the year and so far this year the trend has been upward. It is estimated that 1950's production will exceed 1949's for an equal period of time shortly before the end of July and will end the year with a total about 4.5 per cent higher than last year.

Shortly after the first of the year, talk of imminent crude-oil price cuts was prevelant. Gasoline stocks were considered much too high by some observers. Crude-oil stocks were declining gradually from a postwar peak of 274,691,000 bbl., but were believed to be more than adequate by most oil men, especially in view of large product stocks. The large oil-burning regions of the country had had an exceptionally warm winter. Many domestic producers insisted that the volume of imported oil was too great to support a healthy domestic oil industry. Others thought that the tremendous reserves being developed in Scurry County, Texas, and in western Canada might tip the balance that appeared to them to have been established after the 1949 Texas cutbacks began to have a definite effect on crude stocks.

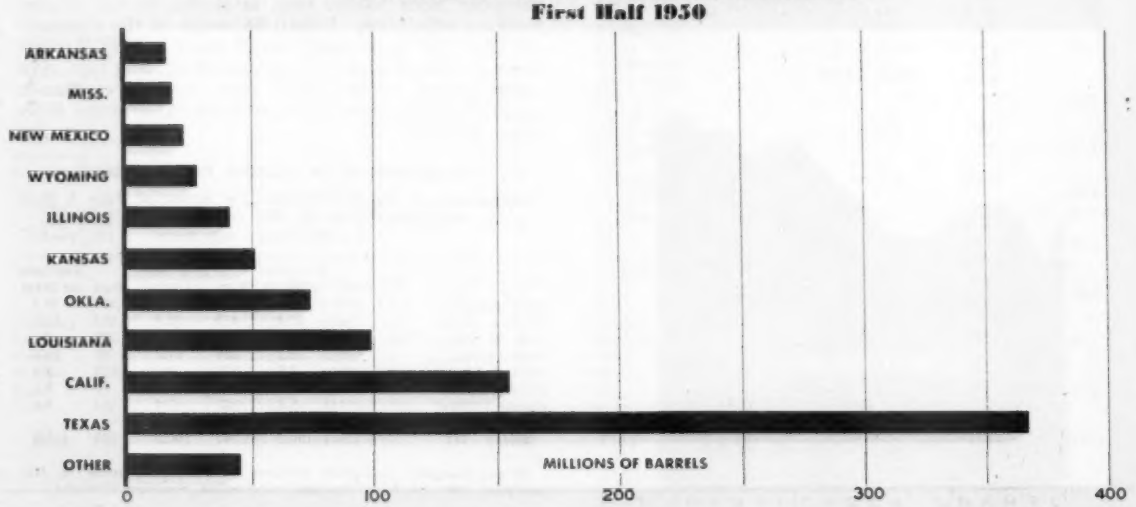
There seemed to be many reasons why a price cut might develop, but, suddenly, early in April, the time when the price cut had been anticipated, the situation changed. To casual observers it seemed that offerings were common one week and refineries were begging for crude the next. Texas began to increase its allowable cautiously and other prorated states followed the big state's example. The demand for Wyoming's black oil, which had dropped overnight, began to pick up. What was the answer? Probably the most important reason for the change was the regained confidence that the high level of economic activity would continue. The suddenness with which the United States went from an "oil shortage" to an "oil surplus" in 1949 had frightened nearly everyone in the oil business. When the expected increase in fuel demand during the latter part of 1949 failed to materialize due to an unusually warm winter, oil people grew more wary. Then the normal approaching summertime pickup in gasoline consumption, a cold spring that drained the heating-oil inventories, and the continued impact of industry that had shifted from coal to oil, made the oil picture look brighter. And, as the picture changed, it became brighter and brighter. The number of drilling wells began to increase until by the end of June the 1949 peak had been surpassed, and the trend is still sharply upward. Refinery runs are trending upward. Gasoline stocks are down to June 1949 levels and all other major product stocks are below 1949 levels for a comparable period.

Statistical Comparison With 1949

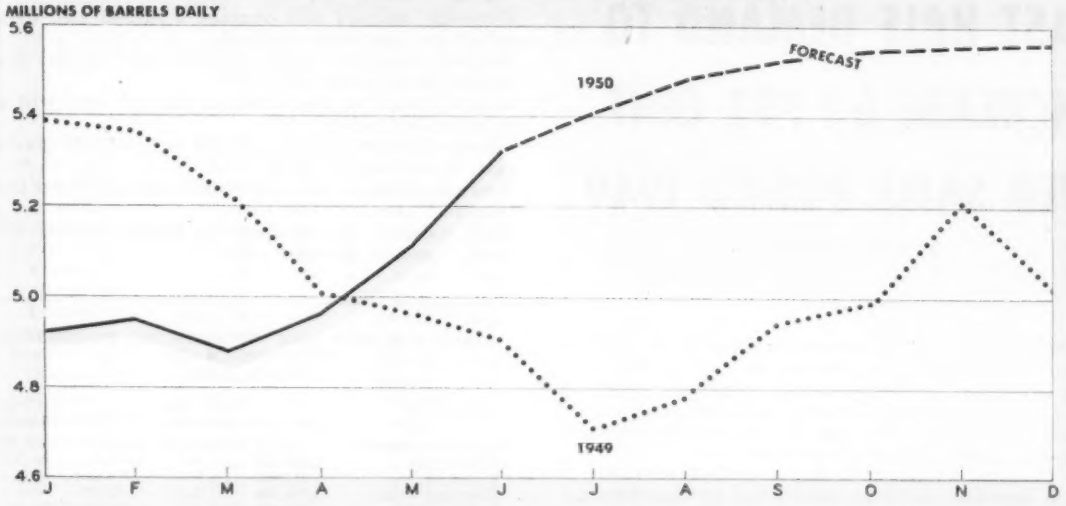
During the first half of 1950 crude-oil production in the United States averaged nearly 5,030,000 bbl. per day, essentially the same as the year 1949's daily average of 5,043,000 bbl.

In the first half of 1949 production was decreasing steadily from the all-time monthly peak of 177,386,000 bbl. (5,722,000 bbl. daily) set during December 1948. Production decreased from 167,072,000 bbl. in January to 147,098,000 bbl. in June to cut the 6-month total to 970,753,000 bbl.

So far this year the trend has been upward. For



Crude-Oil Production



FIRST HALF 1950 PRODUCTION—PRINCIPAL CHANGES
(Thousands of barrels)

State—	1950 first half	1949 first half	Change
Texas	368,497	411,324	—42,827
California	156,244	170,923	—14,679
Louisiana	99,625	100,735	—1,110
Oklahoma	74,210	75,378	—1,168
Kansas	50,571	51,538	—967
Illinois	31,005	31,610	—605
Wyoming	28,623	22,965	+5,658
New Mexico	23,051	26,123	—3,072
Mississippi	18,338	20,192	—1,854
Arkansas	15,381	15,220	+161
All others net	44,828	44,745	+83
Total United States	910,373	970,753	—60,380

the first 4 months of 1950 production was relatively steady in the neighborhood of 4,935,000 bbl. per day. In May the daily average production increased to 5,055,000 bbl. and in June to 5,285,000 bbl. The total production for the first 6 months of 1950 was 910,373,000 bbl., 60,380,000 bbl. less than for a like period in 1949.

During the first half of last year when production was decreasing, it was Texas that bore the brunt of the cutback. This year it is Texas that is carrying the load of the increase chalked up since the beginning of the year.

There were no changes in the order of ranking among the five largest producing states during the first half of 1950. Texas continued in first place by a very large margin. California, Louisiana, Oklahoma, and Kansas followed in that order.

In the second group of five large producing states, Illinois was the leader with Wyoming regaining second place from New Mexico. Mississippi and Arkansas continued to occupy fourth and fifth places in the second five, the same as last year.

United States Production—First Half Year

	1950 Daily average (bbl.)	Thousands of barrels 1950	1949	1948	1947	1946	1945	1944	1943	1942
Alabama	1,624	294	217	231	181	192	79	8	.....	.....
Arkansas	84,978	15,381	15,291	15,592	14,523	13,944	14,493	14,579	13,314	13,233
California	863,226	156,244	169,746	171,119	163,558	154,722	165,801	151,049	139,793	114,511
Colorado	60,028	10,865	11,806	8,312	6,972	4,975	1,909	1,430	1,085	1,032
Florida	1,083	196	232	142	99	30	11	8	.....	.....
Illinois	171,298	31,005	31,610	31,664	33,654	37,732	37,492	39,095	41,860	57,806
Indiana	27,354	4,951	4,403	3,125	3,089	3,378	2,365	2,559	2,694	3,557
Kansas	279,398	50,571	52,130	54,067	50,809	46,636	48,629	49,553	54,712	45,100
Kentucky	25,287	4,577	4,118	4,386	4,573	5,374	4,959	4,232	3,383	2,114
Louisiana	550,414	99,625	94,297	87,917	76,759	68,724	64,606	64,308	59,897	57,840
Michigan	45,127	8,168	8,085	8,180	7,744	8,548	8,718	9,445	10,566	10,357
Mississippi	101,315	18,338	19,643	21,876	16,001	10,460	9,254	7,667	9,940	15,862
Montana	21,961	3,975	4,684	4,514	4,190	4,484	4,223	4,337	3,737	3,980
Nebraska	1,945	352	114	104	111	157	159	208	378	701
New Mexico	127,354	23,051	24,148	23,323	19,109	17,943	18,877	20,284	18,296	15,228
New York	11,492	2,080	2,151	2,306	2,347	2,431	2,263	2,363	2,555	2,692
Ohio	9,199	1,665	1,710	1,736	1,467	1,443	1,391	1,500	1,626	1,771
Oklahoma	410,000	74,210	76,122	74,852	68,003	67,889	68,176	80,703	61,812	71,615
Pennsylvania	31,254	5,657	5,813	6,350	6,254	6,442	6,279	7,296	8,089	9,015
Texas	2,035,895	368,497	380,591	441,712	388,428	372,028	391,282	354,979	258,656	236,460
Utah	3,188	577	114	.....	.....	.....	.....	.....	.....	.....
West Virginia	7,945	1,438	1,353	1,319	1,252	1,503	1,450	1,570	1,707	1,787
Wyoming	158,138	28,623	22,762	26,548	21,023	19,118	18,583	16,178	16,551	16,219
Miscellaneous	182	33	45	47	74	37	27	27	24	22
Total United States	5,029,685	910,373	931,206	989,422	890,220	848,190	871,026	813,376	710,675	680,902
Daily average (bbl.)	.....	5,029,685	5,144,785	5,436,385	4,918,343	4,686,133	4,812,298	4,469,110	3,926,381	3,761,890

XUM

LAST HALF DEMAND TO INCREASE 6.1 PER CENT OVER SAME PERIOD 1949

By E. T. KNIGHT*

FORECASTS—LAST HALF 1950

Domestic demand will average 6,359,500 bbl. daily, up 6.8 per cent from last year.
Refinery runs in fourth quarter will exceed first quarter runs by 8.4 per cent.
Crude-production requirements for last half will be 5,516,500 bbl. daily.
Middle-distillate demand will be 14.3 per cent greater than in last half of 1949.
Domestic demand for gasoline will be up 6.1 per cent from last year.
Total demand for distillates in fourth quarter will show a gain of 20.8 per cent.

TOTAL petroleum demand is expected to average 6,633,500 bbl. daily for the last half of this year, an increase of 379,500 bbl. daily or 6.1 per cent over the same period last year. Since exports will be down about 8.8 per cent, the gain in domestic demand will be even larger, about 6.8 per cent.

If demands and stock levels for the remainder of 1950 approximate those anticipated by this forecast, requirements of United States crude-oil production will average nearly 5,516,000 bbl. daily during the last 6 months of the year. Production at that rate will be nearly 9.9 per cent or 495,000 bbl. daily more than the estimated rate of production during the first half of 1950. (Table 6 compares the forecast demands for crude-oil production with the recorded production in recent past periods.)

To meet projected demands and provide for the stock accumulations indicated, refineries in the United States will be required to operate at peak rates during the coming months, processing during the fourth quarter of 1950, 5,830,000 bbl. of crude oil daily, a rate which will be 51 per cent greater than in 1941 and 8.4 per cent more than the recorded operations during the first quarter of 1950. (See Table 7.)

The levels of general business activity, recent and current, have created demands for petroleum products during the first half of the year somewhat above those that had been expected when a forecast of oil-industry operations for 1950 was presented in The Oil and Gas Journal, January 26, 1950. Accordingly, the forecast for the entire year has been revised, showing a "new look" at the demands that may be expected throughout 1950 and the first quarter of 1951 along with the oil-industry operations required if those demands are to be supplied in full.

TABLE 1—SUPPLY-DEMAND OF PETROLEUM PRODUCTS
(Barrels daily)

	First 6 months 1950 actual and estimated	Last 6 months 1950 forecast	6 mos. ending 3-31-51 forecast
Domestic demands:			
Motor fuel	2,582,620	2,760,000	2,521,500
Kerosine	311,720	313,300	435,400
Distillate fuels	1,110,630	1,030,000	1,416,100
Residual fuels	1,503,780	1,396,000	1,555,500
All other	755,440	860,200	794,100
Total domestic	6,264,190	6,359,500	6,722,600
Exports:			
Crude oil	81,040	85,000	77,500
Products	195,370	189,000	173,900
Total exports	276,410	274,000	251,400
Total demand	6,540,600	6,633,500	6,974,000
Supply:			
Crude production	5,021,470	5,516,500	5,535,100
Domestic supply of other hydrocarbons	473,370	489,100	500,500
Imports	788,370	775,500	818,000
Total supply	6,283,210	6,780,100	6,853,600
Crude and products stock change	—257,390	+146,600	—120,400

*Petroleum economist, The Atlantic Refining Co.

TABLE 2—SUPPLY AND DEMANDS FOR PETROLEUM PRODUCTS IN 1950
(Barrels daily)

	Forecast 1-26-50	Per cent increase over 1949	Forecast current	Per cent increase over 1949
Domestic demands:				
Motor fuel	2,622,000	+ 4.7	2,672,000	+ 6.8
Kerosine	312,300	+10.6	312,400	+11.1
Distillate fuels	1,046,700	+15.3	1,070,000	+19.1
Residual fuels	1,390,000	+ 2.6	1,449,500	+ 6.8
All other and losses	810,000	+ 6.3	808,300	+ 6.0
Total domestic	6,181,000	+ 6.3	6,312,200	+ 9.0
Exports:				
Crude oil	92,500	+ 3.2	83,000	— 8.4
Products	217,500	— 8.7	192,200	—18.8
Total exports	310,000	— 5.4	275,200	—15.9
Total demand	6,491,000	+ 5.7	6,587,400	+ 7.6
Supply:				
Crude-oil prod.	5,340,500	+ 5.8	5,271,100	+ 4.5
Domestic supply of other hydrocarbons	438,800	+ 3.4	480,700	+12.2
Imports	709,700	+ 9.6	781,900	+21.9
Total supply	6,489,000	+ 6.0	6,533,700	+ 6.9
Crude and products stock change	—2,000		—53,700	

A comparison of the current forecast with the previous one shows that the greatest upward revisions for the year 1950 have been in demands for distillate and residual fuels. Domestic demands for other products will also be greater than hitherto anticipated. In addition, revisions in exports and imports had a large effect in changing the over-all picture. (See Table 2.)

The problem of imports of crude and products is in an unsettled state. The rate of imports is a pure conjecture and the amounts employed in this forecast are for statistical purposes only and are in no sense a recommendation. Variations of actual imports from these amounts will result in changes in the projections of other basic operations.

In addition to the year figures for 1950, forecasts of oil-industry operations for the last half of the year and the 6 months ended March 31, 1950, have been compared with the actual and estimated figures for the first 6 months of 1950. (See Table 1 and details in Tables 3 and 4.)

In preparing this forecast of demands and required operations it was considered that temperatures throughout the period would be normal, and that stocks of crude oil would remain at nearly current levels. Stocks of the four principal products on specific dates are expected to change as indicated in

Table 3—Demand and Supply of Petroleum Products, 1950

(Barrels daily)

Demand—	First quarter— Actual	Per cent inc. over 1949	Second quarter— Partially estimated	Per cent inc. over 1949	Third quarter— Forecast	Per cent inc. over 1949	Fourth quarter— Forecast	Per cent inc. over 1949	Year—1950 — Forecast	Per cent inc. over 1949
Motor fuel	2,379,960	4.0	2,915,000	5.3	2,935,000	5.3	2,725,000	5.3	2,740,200	5.0
Domestic	2,322,370	7.7	2,840,000	7.5	2,860,000	5.9	2,660,000	5.9	2,672,000	6.8
Exports	57,590	—56.3	75,000	—41.1	75,000	—23.6	65,000	—14.5	68,200	—36.9
Kerosine	431,570	12.8	206,100	14.4	225,000	7.6	415,000	8.7	319,000	10.7
Domestic	425,090	14.3	199,600	15.6	218,500	7.0	408,000	8.2	312,400	11.1
Exports	6,480	—40.0	6,500	—13.3	6,500	32.9	7,000	50.5	6,500	— 4.9
Distillate fuels	1,430,170	13.5	860,000	32.4	800,000	10.4	1,325,000	20.8	1,102,700	18.3
Domestic	1,394,380	15.2	830,000	34.3	770,000	10.5	1,290,000	20.3	1,070,000	19.1
Exports	35,790	—28.0	30,000	— 5.9	30,000	7.8	35,000	43.0	32,700	— 2.1
Residual fuels	1,716,210	11.5	1,370,000	11.8	1,310,000	3.6	1,542,000	0.3	1,483,600	6.6
Domestic	1,674,440	11.3	1,335,000	12.1	1,280,000	3.7	1,512,000	0.8	1,449,500	6.8
Exports	41,770	17.1	35,000	— 1.1	30,000	—24.7	30,000	—20.3	34,100	— 1.5
Lubricants	131,500	13.4	140,000	7.3	150,000	15.2	140,000	9.9	140,500	11.5
Domestic	94,280	17.6	100,000	8.4	110,000	14.5	105,000	12.9	102,400	13.2
Exports	37,220	3.9	40,000	4.7	40,000	17.0	35,000	1.9	38,100	6.9
Wax	10,470	12.9	10,500	31.9	10,000	13.5	10,000	0.3	10,200	13.3
Domestic	7,470	27.3	8,000	51.7	7,500	14.0	8,000	14.4	7,700	24.6
Exports	3,000	—11.8	2,500	— 7.1	2,500	12.1	2,000	—22.9	2,500	—11.3
Asphalts, domestic*	76,280	14.8	150,000	3.0	200,000	— 2.5	130,000	6.0	139,400	3.0
Road oils, domestic*	3,880	—44.4	25,000	5.3	40,000	—10.6	10,000	— 0.3	19,800	— 7.6
L.P.G. (incl. L.R.G.) domestic*	230,810	20.2	205,000	27.2	210,000	21.1	250,000	16.3	224,000	20.8
Misc. products and losses	259,240	— 8.8	290,000	—10.7	290,000	— 5.9	280,000	4.1	279,900	— 5.6
Domestic†	249,400	— 2.1	280,000	— 9.3	280,000	— 4.4	270,000	5.7	269,900	— 4.1
Exports	9,840	—38.3	10,000	—37.8	10,000	—33.7	10,000	—26.1	10,000	—34.0
Crude oil	112,170	32.0	130,000	9.2	140,000	—14.8	130,000	0.2	128,100	2.7
Domestic‡	40,180	111.3	40,000	194.8	50,000	—26.2	50,000	40.1	45,100	32.1
Exports	71,990	9.2	90,000	—14.7	90,000	— 6.8	80,000	—14.9	83,000	— 8.4
Total demand for all oils	6,782,260	8.8	6,301,600	9.9	6,310,000	4.8	6,957,000	7.2	6,587,400	7.6
Domestic	6,518,580	10.8	6,012,600	11.9	6,026,000	5.5	6,693,000	7.9	6,312,200	9.0
Exports	263,680	—24.5	289,000	—20.7	284,000	— 8.0	264,000	— 8.2	275,200	—15.9
Supply—										
Stock changes	—578,310		+60,000		+388,600		— 95,400		—53,700	
Crude oil	—134,730		—6,000		+ 33,000		+ 41,000		—16,000	
Products	—443,580		+66,000		+355,600		—136,400		—37,700	
Total new supply	6,203,950	— 2.0	6,361,600	6.8	6,698,600	14.5	6,861,600	8.7	6,533,700	6.9
Imports	801,880	37.4	775,000	31.9	735,000	18.6	816,000	5.6	781,900	21.9
Crude oil	457,950	9.3	450,000	11.8	465,000	14.7	476,000	1.1	462,300	8.9
Products	343,930	108.9	325,000	75.7	270,000	25.5	340,000	12.6	319,600	47.3
Domestic supply	5,402,070	— 6.0	5,586,600	4.1	5,963,600	14.1	6,045,600	9.1	5,751,800	5.1
Natural gasoline and related products	481,230	14.4	465,600	15.2	475,600	17.7	500,600	7.3	480,700	12.2
Crude-oil production	4,920,840	— 7.6	5,121,000	3.2	5,488,000	14.2	5,545,000	9.3	5,271,100	4.5
Crude oil run to stills	5,380,470	— 2.1	5,428,000	5.1	5,760,000	9.1	5,830,000	8.3	5,601,300	5.1
Crude oil transferred to products	20,880	—15.8	19,000	— 9.0	20,000	6.7	20,000	15.4	20,000	— 2.0

*Exports included in miscellaneous exports. †Includes refinery losses. ‡Crude oil used as such and losses.

Table 5, which levels should permit efficient operations and avoid burdensome stock accumulations.

Motor Fuel

Factors considered in the upward revision of domestic demands for motor fuel are:

1. The increased rate of passenger-car production.
2. A more intensive use of registered vehicles.
3. Somewhat greater requirements of the agricultural industry than previously forecast.

Kerosine

Domestic demands for kerosine during the second quarter of this year are slightly below those previ-

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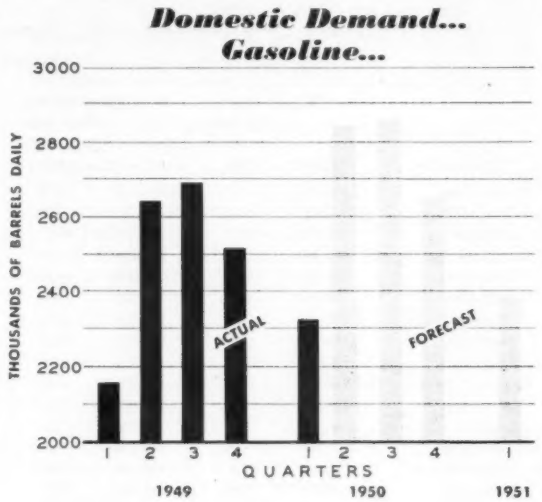
TABLE 4—DEMAND AND SUPPLY OF PETROLEUM PRODUCTS—1950-51

	First quarter 1951		Six months ending March 31, 1951	
Demand—	Forecast	Per cent inc. over 1950	Forecast	Per cent change over prev. year
Motor fuel	2,435,000	2.3	2,581,500	3.9
Domestic	2,380,000	2.5	2,521,500	4.3
Exports	55,000	— 4.5	60,000	—10.3
Kerosine	470,000	8.9	442,200	8.8
Domestic	463,500	9.0	435,400	8.5
Exports	6,500	0.3	6,800	22.5
Distillate fuels	1,580,000	10.5	1,451,100	15.0
Domestic	1,545,000	10.8	1,416,100	15.0
Exports	35,000	— 2.2	35,000	16.4
Residual fuels	1,620,000	— 5.6	1,580,600	— 2.8
Domestic	1,600,000	— 4.4	1,555,500	— 1.9
Exports	20,000	—52.1	25,100	—36.7
Lubricants	130,000	— 1.1	135,050	4.4
Domestic	95,000	0.8	100,050	6.9
Exports	35,000	— 6.0	35,000	— 2.1
Wax	9,500	— 9.3	9,750	— 4.6
Domestic	7,500	0.4	7,750	7.2
Exports	2,000	—33.3	2,000	—33.1
Asphalts, domestic*	80,000	4.9	105,300	5.6
Road oils, domestic*	7,000	80.4	8,500	21.6
L.P.G. (incl. L.R.G.) domestic*	255,000	10.5	252,500	13.4
Misc. products and and losses	280,000	8.0	280,000	6.0
Domestic†	270,000	8.0	270,000	7.0
Exports	10,000	1.6	10,000	—14.6
Crude oil	125,000	11.4	127,500	5.4
Domestic‡	50,000	24.4	50,000	31.9
Exports	75,000	4.2	77,500	— 6.8
Total demand for all oils	6,991,500	3.1	6,974,000	5.1
Domestic	6,753,000	3.6	6,722,600	5.7
Exports	238,500	— 9.5	251,400	— 8.8
Supply—				
Stock changes	—146,000	....	—120,400	....
Crude oil	....	....	+20,700	....
Products	—146,000	....	—141,100	....
Total new supply	6,845,500	10.4	6,853,600	9.5
Imports	820,000	2.4	818,000	4.0
Crude oil	480,000	5.2	478,000	3.0
Products	340,000	— 1.1	340,000	5.4
Domestic supply	6,025,500	11.5	6,035,600	10.3
Natural gasoline and related products	500,500	4.0	500,500	5.6
Crude-oil production	5,525,000	12.3	5,535,100	10.7
Crude-oil runs to stills	5,860,000	8.9	5,844,800	8.6
Crude oil transferred to products	20,000	— 2.0	20,000	2.1

*Exports included in miscellaneous exports. †Includes refinery losses. ‡Crude oil used as such and losses.



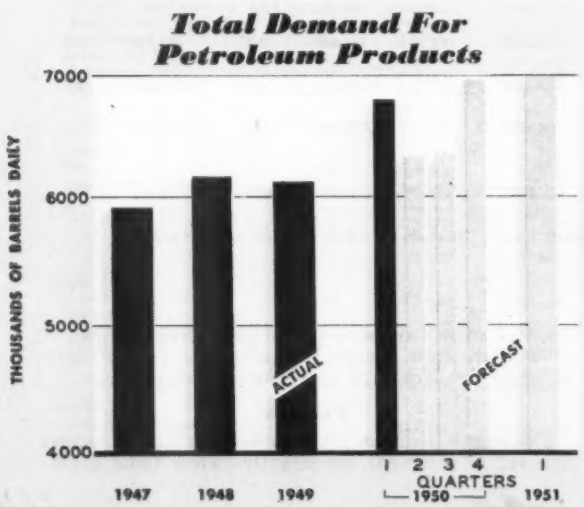
ously forecast for that period. For the remaining periods of the year it is expected that demands will approximate the original projections, and the average yearly demands will be unchanged from those previously forecast.

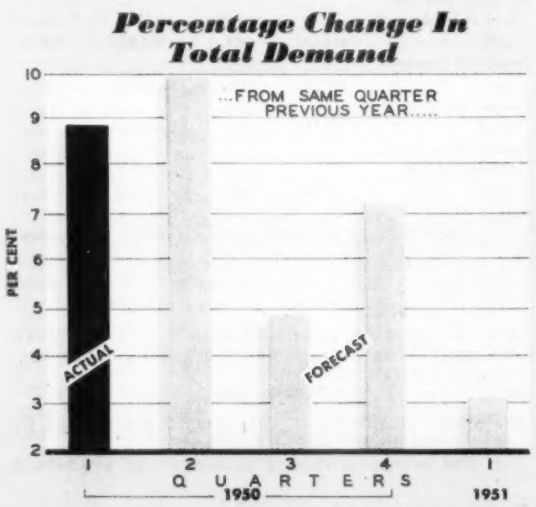
Distillate Fuels

Domestic demands for distillates will be higher than previously forecast for the year 1950, since estimated demands for this product in the second quarter of 1950 exceeded the forecast by 88,000 bbl. daily, part of which may be attributed to below-normal temperatures prevailing in the area of greatest concentration of oil-consuming heating units. However, distillate demands for the coming 6 months should approximate the amount forecast earlier.

Residual Fuel

No material change has been made in demands projected for the closing months of the year. It will be noted, however, that estimated domestic consumption of residual fuel during the first 6 months exceeded the levels heretofore expected by approximately 120,000 bbl. daily or 8.6 per cent. A portion of this variation is attributable to unusual weather in the second quarter of this year, but primarily this increase can be attributed to the unusual (and in





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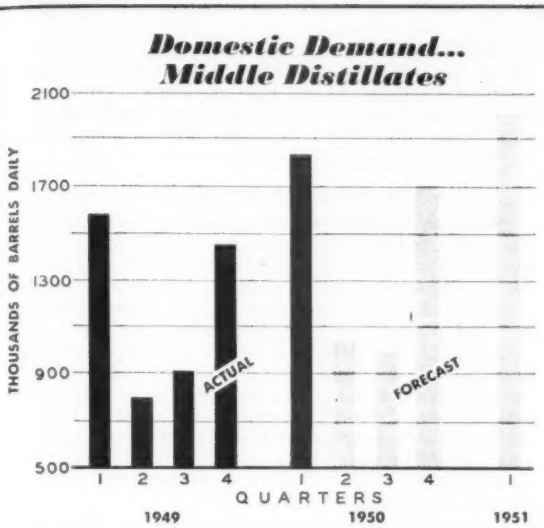


some instances nonrecurring) demands for petroleum fuels resulting from conditions in the coal industry. In order to supply these unexpected demands the oil industry was required to seek supplies in foreign lands.

Liquefied Petroleum Products

Progress made in the production and distribution of L.P.G. has been greater than previously anticipated and has necessitated raising previous forecasts.

Exports

The forecast of exports considers the trends in the recent past and assumes that changes in monetary values in other countries have shown nearly their full effect in the demands for United States crude oil and products. The levels of exports included in this forecast do not reflect the effects of any new agreements that may have been reached in the recent past.

There appears to be no question of adequacy of supply of raw material or operating facilities necessary to meet foreseeable demands. However, some problem of storage capacity may arise, and it seems desirable at this time to encourage summer fillups of consumers' heating-oil tanks.

TABLE 5—STOCKS OF PETROLEUM PRODUCTS
(Thousands of barrels)

	Motor fuel	Kerosine	Distillates	Residual
1950—				
January 1	111,443	20,888	75,207	60,193
March 31	133,766	13,001	37,777	41,860
June 30, est.	112,400	21,800	50,970	44,400
September 30	98,400	30,600	81,600	55,400
December 31	109,000	23,600	66,700	52,400
1951—				
March 31	140,500	11,900	35,200	42,900

TABLE 6—UNITED STATES CRUDE-OIL PRODUCTION

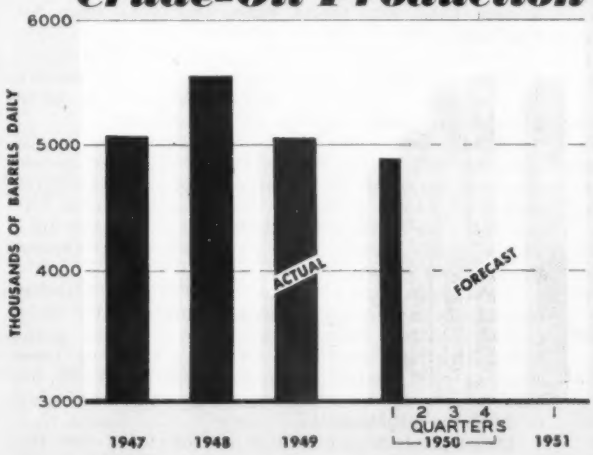
	Barrels daily	Index	
1949:			
Last 6 months	4,941,110	100.0	
1950:			
First 6 months, est.	5,021,470	101.6	100.0
Third quarter	5,488,000	111.1	109.3
Fourth quarter	5,545,000	112.2	110.4
1951:			
First quarter	5,525,000	111.8	110.0

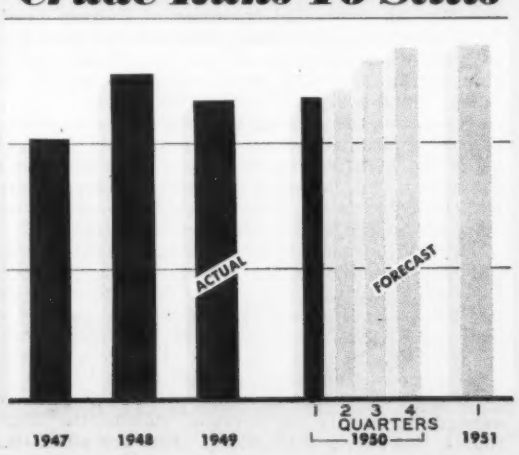
TABLE 7—CRUDE-OIL RUNS TO STILLS IN UNITED STATES

	Barrels daily	Index	
1935-39 average	3,078,130	100.0	
1941	3,860,800	125.4	100.0
1946	4,740,270	154.0	122.8
1947	5,074,650	164.9	131.4
1948	5,596,580	181.8	145.0
1949	5,330,200	173.2	138.0
1950:			
First quarter	5,380,470	174.8	139.4
Second quarter, est.	5,428,000	176.3	140.6
Third quarter	5,760,000	187.1	149.2
Fourth quarter	5,830,000	189.4	151.0
1951:			
First quarter	5,860,000	190.4	151.8

TABLE 8—YIELDS OF PRODUCTS—PER CENT OF CRUDE-OIL RUN

	Motor fuel	Kerosine	Distillates	Residual
1949:				
Fourth quarter	43.48	5.84	18.26	21.47
1950:				
First quarter	43.04	6.29	18.54	21.78
Second quarter, est.	44.00	5.60	18.50	19.90
Third quarter	42.8	5.6	19.5	19.9
Fourth quarter	43.1	5.9	20.0	20.1
1951:				
First quarter	41.9	6.1	20.7	20.1





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PRODUCTION OUTSIDE U.S. AT NEW HIGH— 4,710,000 BBL. DAILY

By DAHL M. DUFF

A RECORD volume of crude oil estimated to have averaged approximately 4,710,000 bbl. daily was produced in foreign fields throughout the world the first half of this year.

This production rate represented an increase of about 13½ per cent over the first half of 1949 and a gain of 30 per cent when compared to the first half of 1948.

Continued high foreign production through the second half of this year appears likely. The trend of foreign production is closely related to that in the United States where increased production and runs are forecast for the remainder of the year.

In the second half of this year, both foreign and domestic operators will be producing to meet an expected heavy winter petroleum demand. Outside the United States, indications are that product demand is increasing rapidly.

The production record in foreign areas for the first 6 months was accomplished despite several unsettling influences. The strike in Venezuela in May forced that country's output down sharply. In February, Venezuelan producers voluntarily reduced production at the government's request because of the campaign for oil import restrictions in the United States.

Currency difficulty continues to plague most American operators in foreign areas. Recently, however, there have been encouraging signs that some of these exchange difficulties are being overcome. French and Italian currencies have strengthened notably, and individual company arrangements with the British Government have relaxed to some extent the restrictions on the use of sterling by American companies.

The 4,710,000-bbl. daily estimate of foreign production the first half of this year includes Russia and the Russian-dominated countries of Eastern Europe. In these Communist areas, figures on oil production, as with other industrial output, is a closely guarded state secret. Estimates have been made, but the lack of any reliable reports makes this difficult.

Excluding the Russian-controlled areas—whose internally consumed output has practically no significance in the world oil trade anyway—total foreign production this first half of the year averaged about 3,852,000 bbl. daily. This was 14.3 per cent greater than production in the same period of 1949.

Foreign production dropped off considerably during the early months of 1949 as a reaction to the end of the postwar oil shortage. Since then, the production curve has been moving steadily upward except in February which reflected the voluntary cutbacks in Venezuela and again in May when the week-long strike in Venezuela reduced output.

While over a long-term period foreign production depends primarily on demand outside the United States, short-term fluctuations often are attributable to conditions in this country. A poor market for fuel oil on the Atlantic seaboard will cause oil to back up in Venezuela. When this oil seeks a market in Europe, the Persian Gulf is affected. Such relationships show the interrelated and world-wide character of the petroleum industry.

First-Half 1950 Developments and Outlook

Western Hemisphere.—In Venezuela, production the first 6 months of this year showed a gain of 13.6 per cent over the depressed level of production for the corresponding period of 1949. Second-half output is expected to be still higher due to winter demand for Venezuela's fuel-oil-type crudes.

Prospects of additional restrictions against oil imports in the United States cloud the outlook for Venezuela. However, no action by Congress is anticipated this session. Improved demand in western Europe, currency-import agreements by American refiners in Argentina, the coal strike and better demand in the United States, all contributed to the high level of Venezuelan output the first half.

Colombia's production is expected to average about 95,000 bbl. daily for the entire year. This would be a record for the country. The increased production rate is due to new stations which enlarged capacity on the Andian National pipe line to the Caribbean. While production rose to a new record in April, exploration activities in this country dropped to a new low with four geological and two geophysical parties operating.

Canadian production continues to be held to about 65,000 bbl. daily pending the opening of the Edmonton-Great Lakes pipe line. Some increase is expected later in the year with the completion of the first leg of the line to Regina. Production of crude in Mexico during the first half showed a major increase of more than 19 per cent, reflecting particularly continued development of Poza Rica.

At the southern tip of the hemisphere, Chile began commercial shipments early in the year from its field in the Tierra del Fuego region. Output is a relatively small 1,500 to 2,000 bbl. daily, but development is continuing by the government-owned corporation.

Europe and Africa.—Germany is extending its leading position as the No. 1 producer in western Europe. Production is expected to be near the 30,000-bbl. daily mark by the end of the year. Most of this additional oil is coming from the Emsland area near the Dutch border.

Gas deposits are being evaluated in the Netherlands, and wildcat drilling is taking place in several parts of the country. France and Italy both have major exploration programs under way, and in France a new field was found early this year near the Pyrenees.

Further development in Egypt is being retarded by a continued unfavorable legal situation. Production here at about 45,000 bbl. daily is believed to be at about a maximum pending further drilling.

Middle East.—One of the most significant events since the end of the war in the international petroleum industry will be the opening of the Trans-Arabian Pipe Line Co. Persian Gulf-Mediterranean line late this year. This line initially will move some 300,000 bbl. daily, avoiding the long tanker haul around the Arabian Peninsula.

Production from all areas of the Middle East has recently been running at about a million and three quarters barrels daily. Despite the currency problems, American producers in the area have been reaching new production records. Sales partially for local currencies and other expedients have been used to meet the situation.

Major production increases are scheduled over the

next 2 years in Iraq. Kirkuk field is a leading Middle East reserve but its output has been limited to what can be moved through existing pipe lines, one of which, the Haifa branch, has been closed due to the Israeli-Arab war. Construction of a 30-in. is to start this fall, and capacity of the existing system to Tripoli is being stepped up.

Of interest in the Persian Gulf was the commencement of commercial production in January from the shiekhdom of Qatar. This is another large reserve which has been increased by testing of deeper horizons in the last year. Production has been at about 25,000 bbl. daily, though some 40,000 bbl. daily was planned for the year.

Kuwait was at a record production level the first half of this year. In this shiekhdom, as in Saudi Arabia, steps are being taken to reduce the dollar component of the production to improve its competitive position in soft-currency markets. Americans are confined to key technical and management positions, and more buying is being done outside the United States.

Far East.—Precise information is lacking on current production levels in the Far East. Standard-Vacuum Oil Co., which with Royal Dutch-Shell is the dominant operator in the area, concluded a renewed agreement this spring with the British Government relating to sales for and expenditures in sterling. The arrangement presumably protects the company's position in its largely sterling markets.

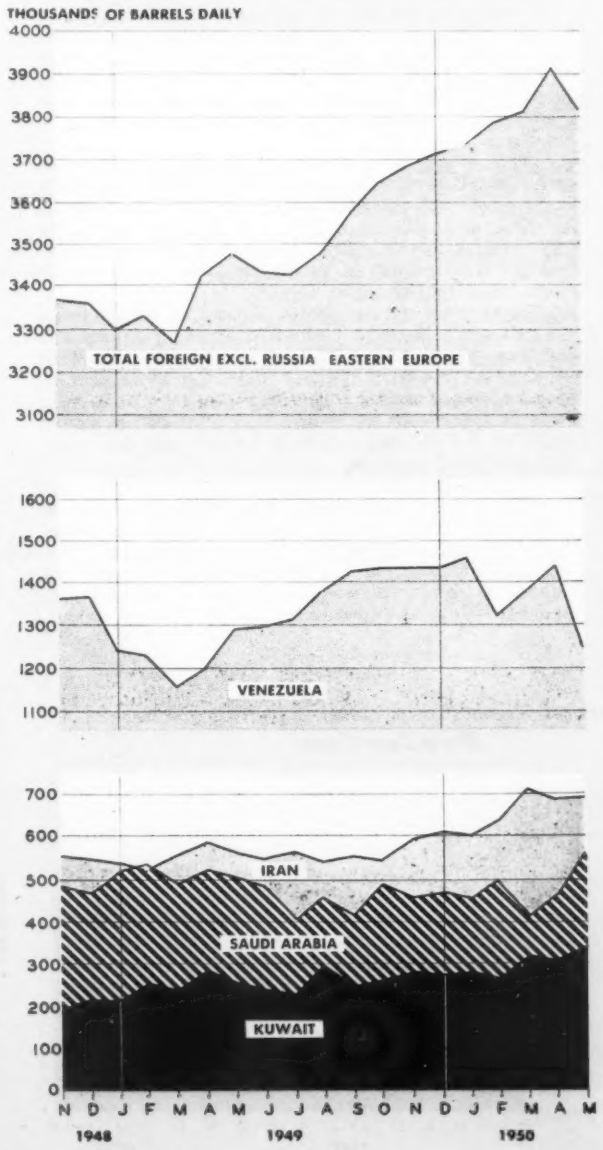
Distressing internal conditions in Burma hold production in this country to only a fraction of its prewar 20,000-bbl.-plus rate. There have recently been a few signs pointing to more stable political conditions in Burma.

FOREIGN CRUDE-OIL PRODUCTION
(In thousands of barrels daily)

Country—	First 6 mo., 1950*	First 6 mo., 1949	Percentage change, 1950 vs. 1949	First 6 mo., 1948
Western Hemisphere:				
Argentina	61.0	61.9	—1.5	63.7
Bolivia	1.8	1.5	20.0	1.0
Brazil	0.9	0.3	200.0	0.3
Canada	62.8	52.9	18.7	26.9
Chile	1.6	.....	.....	.....
Colombia	89.3	81.5	9.6	52.3
Cuba	0.4	0.2	100.0	0.3
Ecuador	7.2	7.2	.....	7.0
Mexico	190.0	159.6	19.1	157.5
Peru	41.0	40.3	1.7	37.0
Trinidad	56.5	56.3	0.4	54.9
Venezuela	1,404.0	1,236.2	13.6	1,309.6
Total	1,916.5	1,697.9	12.9	1,710.5
Europe and Africa:				
France	1.4	1.1	27.3	1.1
French Morocco	0.7	0.4	75.0	0.3
Germany	20.8	14.2	46.5	11.4
Italy	0.2	0.2	.....	0.2
Netherlands	13.8	11.6	19.0	7.6
Egypt	43.9	42.5	3.3	33.5
United Kingdom	1.1	0.9	22.2	0.9
Total	81.9	70.9	15.5	55.0
Middle East:				
Bahrein	30.0	30.2	—0.7	29.6
Iran	665.0	561.3	18.5	481.1
Iraq	115.0	60.7	89.5	97.4
Kuwait	310.0	248.0	25.0	82.6
Qatar	27.0	.....	.....	.....
Saudi Arabia	484.0	508.5	—4.8	331.2
Turkey	1.0	0.8	25.0	.....
Total	1,632.0	1,409.5	15.8	1,011.9
Other Asia:				
British Borneo	77.0	64.3	19.8	49.9
Burma	0.5	0.5	.....	0.5
China	1.5	1.5	.....	1.5
India	5.5	5.3	3.8	5.3
Indonesia	125.0	110.2	13.4	78.8
Japan	5.3	3.5	51.4	3.2
New Guinea	4.6	4.6	.....	.....
Pakistan	2.0	1.5	33.3	1.3
Total	221.4	191.4	15.7	140.5
Total, foreign less Russia and E. Europe	3,851.8	3,369.7	14.3	2,917.9
Estimated Russia and Eastern Europe:				
Austria	22.0	17.5	25.7	17.0
Romania	82.0	90.0	—8.9	79.0
Russia	730.0	650.0	12.3	590.0
Other Eastern Europe	23.0	18.0	27.8	15.0
Total	857.0	775.5	10.5	701.0
Total foreign	4,708.8	4,145.2	13.6	3,618.9

*Partly estimated.

Foreign Crude-Oil Production



LIGHT PRODUCTS UP 14.1 PER CENT OVER FIRST HALF OF 1949

By JOHN C. CASPER

PRODUCTION at natural-gasoline and cycling plants during the first 4 months of this year averaged 20,038,000 gal. daily or 14.1 per cent more than in the same period last year.

Since the larger gains as well as production peaks usually come in the winter months, percentage increases for the second quarter will not be up to the records set in the early months of the year. Production for the first half of the year is expected to be about 9 per cent greater than for the first 6 months of 1949, but gains in the last half of the year will bring the increase for the year up to about 12 per cent.

The greatest increase in the January-April period was in the production of L.P.G., 8,159,000 gal. daily compared with 6,676,000 gal. daily last year. This is a gain of 1,483,000 gal. daily or 22.2 per cent. For the first quarter, plant production of L.P.G. exceeded total output of natural gasoline and natural-gasoline mixtures.

Plant production of finished gasoline and naphtha is still small in comparison with refinery production of these products, but the relative gain for the first 4 months was even greater than the expansion in production of L.P.G. The increase over last year was 32.4 per cent compared with the 22.2 per cent gain for L.P.G. and a gain of 1.8 per cent for refinery-produced gasoline.

Natural-gasoline production was 7.1 per cent greater in the first 4 months than in the same period last year. Total natural-gasoline stocks increased 19,000,000 gal. or 10.9 per cent in January and another 17,000,000 gal. in February. Since the increase at refineries was only about 10,000,000 gal., the big jump in inventories at plants and terminals was enough to produce a sharp drop in the natural-gasoline market.

Group 3 postings for 26-70 natural dropped from 5.5 cents a gallon to 4 cents in the 3-week period ended March 6, but increased demand for motor fuel and the early leveling off of motor-fuel stocks resulted in increased purchases of natural and improvement in the natural market by the first week of April. Group 3 quotations were up to 5.125 cents a gallon before the end of May and to 5.375 cents by the end of June.

One of the primary factors contributing to the instability of the light-products market has been the lack of available storage. When total stocks at plants and terminals reached 257,500,000 gal. at the end of February, current production had to be shipped. In the case of natural gasoline, it took a sharp price cut to move it. The light-products industry will be faced with the possibility of heavy seasonal price cuts until it plans storage to cover stock accumulations at least as large as those for the early months of the past 2 years.

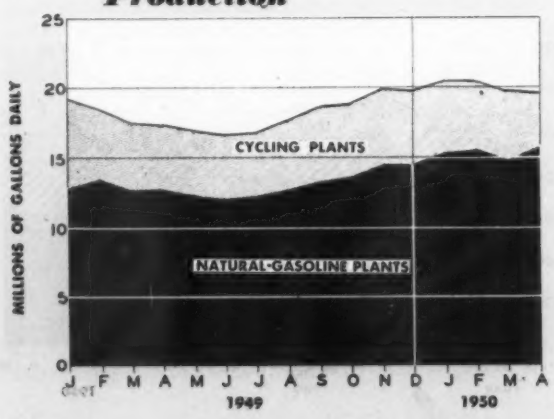
DEMAND FOR LIGHT PRODUCTS AT PLANTS JANUARY—APRIL
(Thousands of gallons daily)

	1950	1949	Change	Per cent change
Natural gasoline	8,266	7,519	+ 747	+ 9.9
For refineries	7,692	7,086	+ 606	+ 8.6
For jobbers	574	433	+ 141	+32.6
Condensate	950	1,029	— 79	— 7.7
For refineries	935	988	— 53	— 5.4
For jobbers	15	41	— 26	—63.4
Finished gasoline	2,163	1,518	+ 645	+42.5
For refineries	398	403	— 5	— 1.2
For jobbers	1,765	1,115	+ 650	+58.3
L.P.G.	8,070	6,673	+1,397	+20.9
For refineries	1,365	1,410	— 45	— 3.2
For fuel and chemical	6,705	5,263	+1,442	+27.4
Other products	349	281	+ 68	+24.2
Exports and losses	182	692	— 510	—73.7
Total	19,980	17,712	+2,268	+12.8

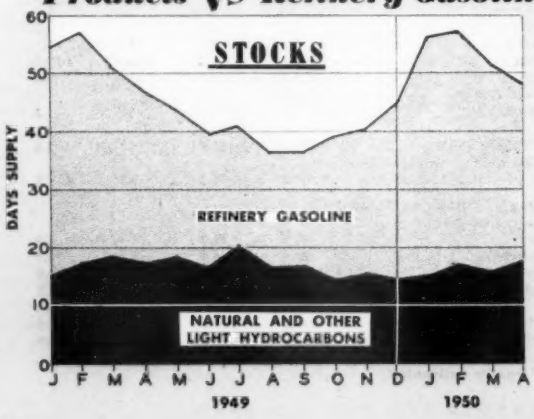
NATURAL-GASOLINE AND CYCLING PLANT PRODUCTION, JANUARY—APRIL
(Thousands of gallons daily)

	1950	1949	Change	Per cent change
Texas	10,191	8,509	+1,682	+19.8
California	3,106	3,178	— 72	— 2.3
Louisiana	2,317	2,109	+ 208	+ 9.9
Oklahoma	1,637	1,365	+ 272	+19.9
Other states	2,787	2,396	+ 391	+16.3
Total	20,038	17,557	+2,481	+14.1

Natural-Gasoline and Cycling-Plant Production



Natural-Gasoline and Other Plant Products vs Refinery Gasoline



REFINERY RUNS SEEN AS REACHING NEW PEAK LAST HALF OF YEAR

REFINERS were running about 7 per cent more crude in the last few weeks of the first half of the year than in the same weeks of 1949. However, the general pattern of refinery operations for the first half represented a marked change from 1949.

Crude runs in January were held to a relatively high level to meet anticipated demands for fuels at the peak of the heating season. However, mild weather in January and February held distillate and kerosine demands below those of December. At the end of January, finished gasoline stocks were still about 8,000,000 bbl. greater than a year earlier. These factors tended to soften product markets and reduce refinery runs.

The change came near the end of February. Delayed winter weather boosted fuel demands in March almost to the levels of the mid-winter months. Kerosine sales in March were actually higher than in February. Despite the weather, domestic demand for gasoline in March was 7.7 per cent greater than a year earlier.

By the end of April it was apparent that runs would have to be raised to cover high gasoline demands in the summer months and to build fuel stocks for next winter. The increase was from 5,195,000 bbl. daily in April to about 5,500,000 bbl. daily in May.

In 1949, excessive product inventories and a leveling off of demand forced reductions in crude runs each month through April with restricted operations through August.

Runs for the first half of this year were only about 1.4 per cent greater than last year, but if expected product demands materialize, refinery operations in the last half will have to be moved up enough to give an annual increase of about 4 or 5 per cent. The relatively high level of runs reached in June must be maintained or raised slightly in the third quarter and increased still further in the fourth.

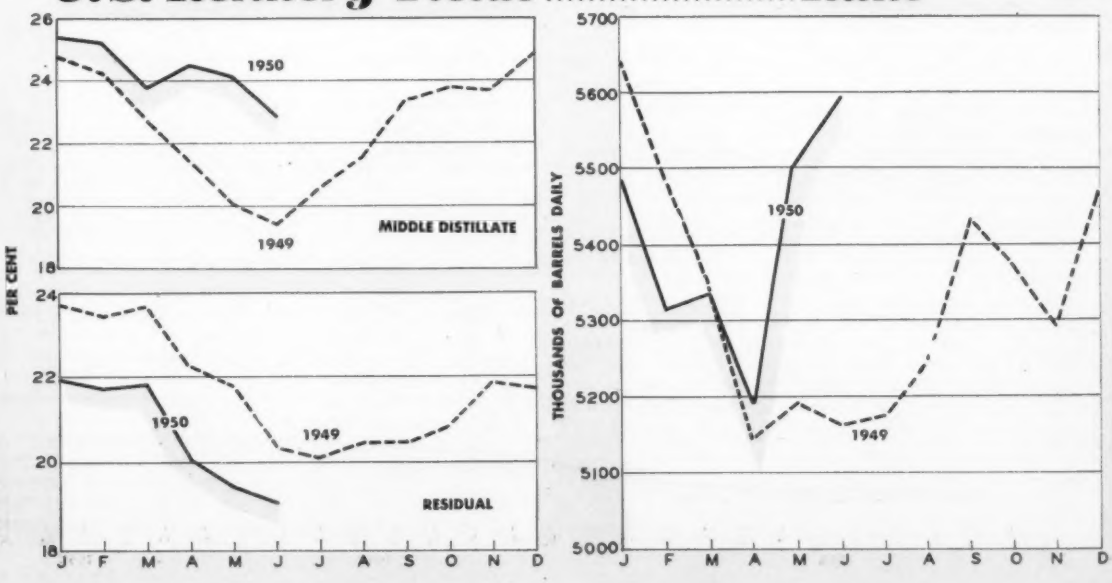
The need for additions to fuel stocks to meet high demands during the heating season is shown by the supply-demand balance for last March. Demand for petroleum products in March averaged 6,914,000 bbl. daily. Product imports supplied 398,000 bbl. daily and natural-gasoline and cycling plants produced 470,000 bbl. daily. About 25,000 bbl. daily of crude was used as fuel or included as loss. This leaves 6,021,000 bbl. daily to be supplied from refinery operations and stock reductions. If stocks had been reduced to minimum levels during the early winter months, runs of better than 6,000,000 bbl. daily would have been required to meet demands in March.

REFINERY RUNS BY DISTRICTS—JANUARY-JUNE
(Thousands of barrels daily)

			Per cent of U. S. Total	
	*1950	1949	1950	1949
East Coast	864	760	16.0	14.3
Appalachian:				
District 1	91	92	1.7	1.7
District 2	70	64	1.3	1.2
Ill., Ind., Ky.	999	899	18.5	16.9
Okla., Kans., Mo.	454	420	8.4	7.9
Inland Texas	203	223	3.7	4.2
Texas Gulf Coast	1,182	1,291	21.9	24.2
La. Gulf Coast	448	423	8.3	7.9
N. La. and Ark.	69	75	1.3	1.4
Rocky Mountain:				
New Mexico	13	12	.2	.2
Other Rocky Mountain	171	157	3.1	2.9
California	842	914	15.6	17.2
Total United States	5,406	5,330	100.0	100.0

*Four months actual, two months estimated.

U. S. Refinery Yields ..... Runs



NATURAL GAS APPEARS HEADED FOR CONTINUED HIGH-LEVEL EXPANSION

By DAHL M. DUFF

THE expansion of the natural-gas industry—one of the most spectacular developments on the post-war American business scene—is expected to continue at a high level over the next several years.

Construction of transmission lines set another record in 1949, but the outlay for work of this type is now expected to be even greater in the current year. Along with this are continuing heavy expenditures being made by the distributing companies.

Existing and building natural-gas transmission lines now extend into every major section of the country except New England and the Pacific Northwest. And in an effort to serve each of these two areas, several companies are at present competing for the necessary government authorizations.

A significant point in the growth of natural gas will be reached this fall with the completion of Transcontinental Gas Pipe Line Corp.'s 30-in. Texas-New York line. Under a recent additional Federal Power Commission permit this 1,000-mile line, the world's longest, will deliver 505,000,000 cu. ft. daily into the New York City area.

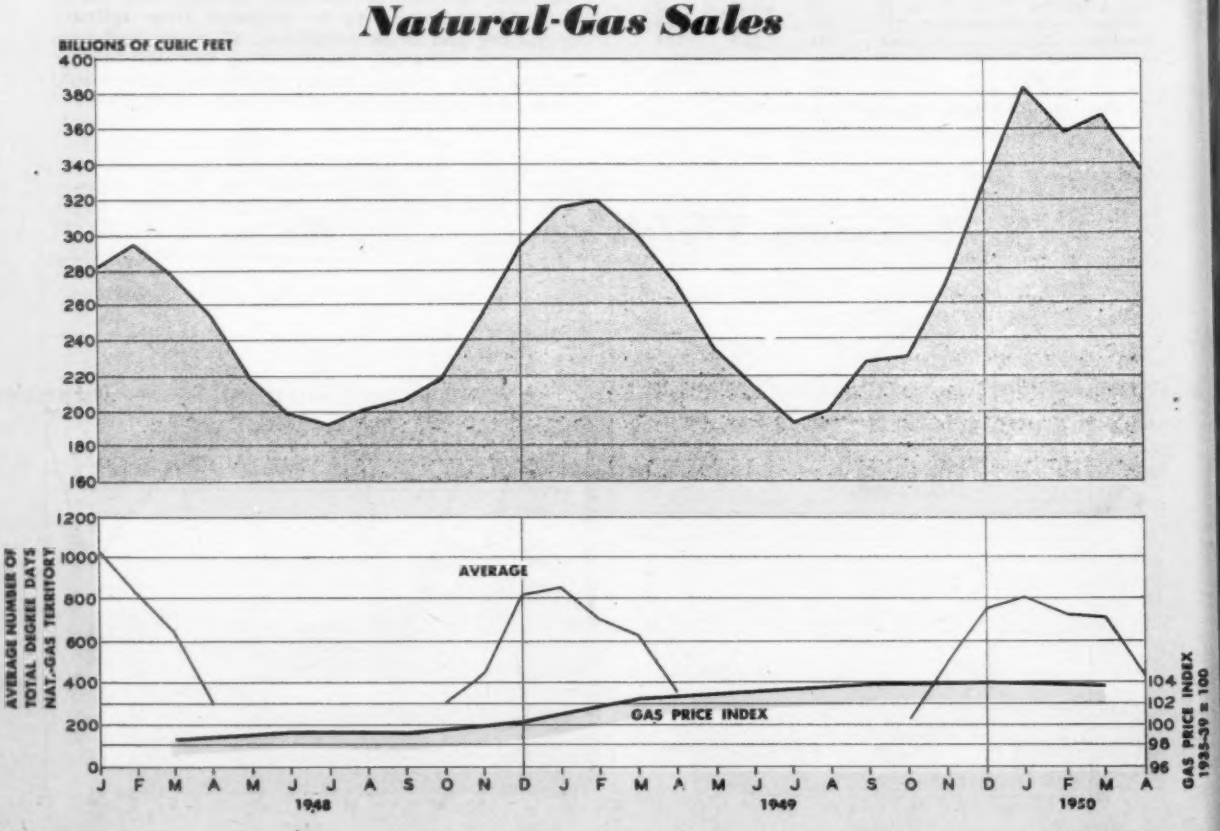
Transcontinental as well as Tennessee Gas Transmission Co. and Texas Eastern Transmission Corp. are all interested in supplying the as yet untouched market for natural gas in New England. The various proposals are being studied by FPC. Several companies, including Westcoast Transmission Co., Ltd., and Northwest Natural Gas Co. are now before the Alberta Conservation Board in Canada asking permits to move gas from that Canadian province into Washington and Oregon.

Phenomenal Utility Sales

These major projects, together with others transporting gas to the South Atlantic Coastal area, the North Central section, and California, are resulting in a phenomenal rise in total utility sales of natural gas. The full effect of this is still considerably in the future. Utility sales last year were some 3.1 trillion cubic feet. Some feel that this annual total will not level off until it reaches 4.5 trillion cubic feet, or more.

On the producing end, the effect of this tremendous growth of the industry is being recorded in competition for undedicated reserves and resulting higher prices for gas at the well head in the Southwest. It has facilitated conservation efforts in Texas and other states by providing outlets for what was once a widely wasted, or at least unutilized, resource.

Even after all necessary long-distance transmis-



sion lines out of producing areas of the Southwest have been built, it is likely that construction work will continue indefinitely in the form of looping programs. The experience of many existing lines bears out this prospect. Tennessee Gas Transmission has been in almost continuous construction, much of it looping, since the original line was laid during the war. Such work arises from the need for expanded deliverability, to meet still greater gas demand.

Influencing Factors

There are naturally many factors that will retard or accelerate these future programs. One is the peak-load problem which is related closely to the question of how far FPC will go in allowing gas to be used as an industrial fuel on an interruptible basis.

The increasing use of gas-storage areas in the Appalachians and North Central section is another effort to meet the problem of heavy winter demand. Colombia Gas system, a major integrated company, for example, built up 100 billion cubic feet storage in the West Virginia area last November. This permitted 800 million cubic feet daily in peak deliverability. Currently storage is being replenished toward a total of 130 billion cubic feet by November to provide a possible 1-billion-cubic-foot daily peak deliverability this winter.

Another question affecting the future of the natural-gas transmission industry is whether—or when—the large blocks of gas reserves available for 20-year dedication to transmission systems will be exhausted. The country's gas reserves are growing, but much of the total is unsuitable or poorly located, and the requirements necessary to back up these major transmission projects are tremendous. Courtney Brown, Standard Oil Co. (N.J.) economist, recently suggested this may prove to be the real limiting factor on natural-gas expansion.

Related to the question of gas-reserve availability is the unsettled matter of FPC regulation of independent gas producers. The presidential veto of the Kerr bill appears to have made many producers still more wary of the possibility of federal regulation from sales to interstate pipe lines. Some natural-gas companies themselves have recently gone into the production end of the business through subsidiaries but this seems to be the exception. Present rules of FPC do not allow charging off exploration expenses, though there is a possibility these restrictions may be relaxed.

On the marketing side, natural gas continues in general to be favored by a relatively low and stable price. For many purposes, it is unquestionably a superior fuel, and the convenience factor weighs with residential users. On the other hand, the oil business will certainly resist further encroachment of its markets by gas. In the Northwest, at present, oil dealers are now engaged in an intensive campaign to promote oil heat.

Gas Popular in Stock Market

Despite problems of peak load, gas-reserve availability, and a government regulation that often is heavy handed, the natural-gas industry continues to become an ever more important part of the nation's fuel economy. Among traders in eastern stock markets, natural gas is a top favorite because of its "growth prospects," its stable earnings, and the fact that labor is not a major element in its costs.

The American Gas Association's statistical department has just compiled its annual survey of construction expenditures in the gas-utility industry. For natural gas, which now far overshadows the manufactured and mixed branches of the industry, this survey shows that the outlay on transmission and distribution will be greater this year than in 1949.

In 1951, transmission expenditures will drop off somewhat, but those for production and storage and for distribution are expected to be still larger. The data are summarized in the following table:

(In millions of dollars)

	1949	1950	1951	1952	1953	1954
Transmission	568	646	565	120	41	38
Distribution	182	194	200	174	164	159
Production and storage	69	87	101	54	60	52
General	29	28	26	17	12	12

In connection with this report, it was pointed out that the totals listed for several years in the future are considerably understated. The data is based on reports from the gas companies themselves which often do not list many projects now tentative and several years off.

Another indication of gas-industry expansion is contained in compilation made by the Gas Appliance Manufacturers Association, Inc., from records of the Federal Power Commission. For the period from July 1, 1945, to January 1, 1950, the commission authorized natural-gas projects involving construction of 26.513 miles of line and the expenditure of $1,682,000,000. This includes the Big Inch system conversion.

Of interest as a sign of future construction is the backlog of applications pending before the commission. On January 1 of this year, these applications provided for 12,700 miles of line with an expenditure of $873,936,000.

New Applications At High Figure

Previous surveys of this association show that despite the large total which has been authorized, new applications continue to keep the total awaiting action at a high figure. On May 15, 1948, applications pending involved 13,515 miles and $903,828,000 and January 1, 1949, 14,559 miles and $1,167,025,000.

When brought down to the more recent date of April 1 of this year, the figures show that the commission had before it at that time applications involving 13,882 miles and $881,125,000 in expenditure. Some of these projects are, of course, duplications, as for example for the New England line where only one company will probably be certified by the commission. However, the figures in general show natural-gas construction is far from having run its course.

The recent A.G.A. report on gas sales shows that for the month of April natural-gas utility sales at 336,020,000,000 cu. ft. were 32.8 per cent over April 1949. While some of this increase was due to the fact that degree-day temperature averaged 21.9 per cent colder than 1949, a substantial part of the increase reflected new installations and the greater use of gas fuel.

Along with the growing volume of natural gas being taken by the utility pipe lines, there appears to be also a greater use in the field and for other purposes such as chemicals and carbon black. The Bureau of Mines estimates total marketed production of natural gas last year, exclusive of that used in field repressuring, to be 5,750 billion cubic feet. This gives a ratio of nearly 54 per cent when compared to total utility sales of about 3,093 billion cubic feet.

This ratio in 1948 was slightly above 56 per cent. In 1947, it was also about 56 per cent. Prewar, the ratio varied from 52 to 55 per cent.

GAS PRICE INDEX 1935-39 = 100

XUM

NATIONAL LUBE CAPACITY AT ALL-TIME HIGH, PLANT SURVEY SHOWS

By GEORGE WEBER

WIDER use of solvent refining, and the concentration of greater capacity in larger plants, are reflected in the 1950 survey of domestic lubricating-oil-manufacturing facilities, compiled by the National Petroleum Association. This year's N.P.A. survey shows a total of 72 separate refineries reporting an aggregate capacity for producing 177,662 bbl. of finished lube oils per day.

The 1950 compilation is of particular interest, as it reveals the present status of the industry following the greatest lube-plant-construction program in history.

With approximately 37,000 bbl. per day added to finished lube capacity in the past 2 years, national productive potential may be expected to level off with relatively minor net additions for the next 2 or more years. Construction of new units of modern design will probably be necessary from time to time to replace obsolete equipment, but the large-scale installation of new plants may be considered as ended for the present.

The N.P.A. survey concerns capacity only and does not reflect yields in the individual plants. Of the total of 72 plants surveyed, only 5, with a total capacity for 3,700 bbl. daily, were reported shut down for reasons other than strikes. None of the five employs any type of solvent refining.

Solvents Now the Rule

The dominance of solvent extraction, dewaxing, and deasphalting in modern lubricating-oil manufacture is well illustrated in the survey. Of the 72 refineries submitting capacity figures, 39 with a total of 154,058 bbl. capacity employ one or more methods of solvent refining. Actual capacity for solvent-refined oils in this country this year is estimated by Keyser* to be 103,000 bbl. per day. The U. S. Bureau of Mines reports that daily average production of all lubricating oil for the first quarter of 1950 amounted to 129,000 bbl.

Solvent lube facilities may be estimated as operating currently at about 90 per cent capacity, producing 92,700 bbl. daily. This represents about 72 per cent of total national production at present.

The survey lists 33 plants, accounting for 13 per cent of total capacity, which employ no solvent refining processes. These plants rely on acid and clay and other "conventional" methods of lube refining. It now appears that the term conventional more rightly applies to plants using various types of solvent refining.

Altogether, 13 solvent refining processes are listed as in use. Methylethylketone-benzol solvent dewaxing leads the list with installations in 24 refineries while propane dewaxing and propane deasphalting units are reported in 18 lube plants. Furfural refining, phenol, and Duo-Sol, among the leading processes, show installations in 16, 15, and 9 refineries respectively. Among the other processes employed are Chlorex, sulfur dioxide, nitrobenzene, Alchlor, Barisol, R.P.M. solvent, and acetone-benzol.

Installed capacities of all of the three general classifications of solvent refining showed increases during the past year. Including some known capacity figures for new units, not reported in the survey, the comparative figures for April 1949 and May 1950 are as follows:

CHARGE CAPACITIES IN SOLVENT REFINING UNITS

Type of solvent refining—	Charge Capacities, bbl. 1949	1950
Solvent extraction	181,020	191,820
Solvent dewaxing	119,808	128,000
Propane deasphalting	60,000	62,530

The 1949 survey listed a number of units then still under construction. Actually, the intervening year saw the commencement of operations of new units totaling, in daily feed charge capacity, 31,750 bbl. for solvent extraction, 28,750 bbl. for solvent dewaxing, and 11,080 bbl. for propane deasphalting.

The 1949 survey showed a total of 172,597 bbl. of daily productive capacity. This total included a number of units not yet in operation. The actual addition to operating capacity in this country during the past year was approximately 19,000 bbl. per day. Offsetting the gains of new plants were scaled-down estimates on five refineries, reflecting retirement of equipment or increased severity of operation. While some plants are now shut down, no abandonments were reported.

Geographical Distribution

The 1950 survey shows some slight changes in regional capacity. Midwestern and eastern plants made some gains while Gulf Coast capacity dropped slightly.

GEOGRAPHICAL DISTRIBUTION OF LUBE-OIL PLANTS

Region—	No. plants	Capacity, B.P.D. Total	Average	Per cent National
Eastern	7	34,300	4,900	19.3
Pennsylvania area	19	20,500	1,080	11.5
Midwestern	11	16,400	1,490	9.2
Southwestern	17	20,989	1,230	11.8
Gulf Coast	10	68,133	6,810	38.4
Pacific and Mountain	8	17,340	2,170	9.8
Total	72	177,662	*2,470	100.0

*National average.

The trend toward greater plant size continues. The 11 largest plants, capable of producing 5,000 bbl. per day and over, accounted for over 50 per cent of national capacity. On the other hand, the 24 smallest plants with output potential of less than 1,000 bbl. per day show aggregate capacity of less than the nation's largest single installation.

Figures submitted by the individual refiners show the top 12 plants in this country at the present time to be:

TWELVE LARGEST PLANTS

Rank, company and location—	Capacity b.p.d.
1. The Texas Co., Port Arthur, Tex.	16,000
2. Humble Oil & Refining Co., Baytown, Tex.	12,200
3. Gulf Oil Corp., Port Arthur, Tex.	12,000
4. Sun Oil Co., Marcus Hook, Pa.	11,800
5. Standard Oil Co. of Calif., Richmond, Calif.	9,000
6. Esso Standard Oil Co., Baton Rouge, La.	7,500
7. Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.	7,400
8. Esso Standard Oil Co., Bayonne, N. J.	6,500
9. Cit-Con Oil Corp., Lake Charles, La.	6,000
10. Magnolia Petroleum Co., Beaumont, Tex.	5,400
11. Atlantic Refining Co., Philadelphia	5,000
12. Mid-Continent Petroleum Corp., Tulsa	5,000

CLASSIFICATION OF LUBE-OIL PLANTS
(By productive capacity)

Capacity, b.p.d.	No. plants	Per cent total	Capacity	Per cent total
Under 1,000	24	33	12,224	6.9
1,000-2,499	31	43	46,405	26.1
2,500-4,999	5	7	15,233	8.6
5,000 and over	12	17	103,800	58.4
	72	100	177,662	100.0

*World Lubricating-Oil-Production Capacity and its Relation to Demand" by P. V. Keyser, Jr., Socony-Vacuum Oil Co., Inc., presented to National Petroleum Association, Atlantic City, N. J., September 15, 1949.

United States Refineries Producing Lubricating Oils

Company—	Refinery location	Crude capacity (B/D)	Solvent extraction	Solvent dewaxing	Propane deas-phalting	Finished lube capacity	Lube processes
Atlantic Refining Co.	Philadelphia	117,000	5,600	3,500	3,500	5,000	Nitrobenzene, phenol, MEK-benzol, propane, acid-clay
Bayou State Oil Corp.	Hosston, La.	800				400	Acid and clay
Berry Asphalt Co.	Waterloo, Ark.	1,500				350	Conventional vacuum
Calumet Refining Co.	Burnham, Ill.	1,200				750	High vacuum distillation
Calumet Refining Co.	Princeton, La.	700				425	Crude distillation, acid-clay
Champlin Refining Co.	Enid, Okla.	20,000	2,850			1,800	Duo-Sol, phenol
Citcon Corp.	Lake Charles, La.		17,500	8,500		6,000	Duo-Sol, Furfural, MEK-ben.
Cities Service	Ponca City, Okla.	15,000				1,050	Acid and clay
Cities Service	Titusville, Pa.	3,000				725	Conventional
Continental Oil Co.	Ponca City, Okla.	52,500	3,850	1,850		1,800	Duo-Sol, Furfural, MEK-benzol, Barisol
Cooperative Refining Association	Coffeyville, Kans.	18,000	1,800	1,500		3,000	Furfural, MEK-benzol
Henry H. Cross Co.	Smackover, Ark.	6,000				1,000	Vac. dist., acid and clay
Crown Central Petroleum Corp.	Houston	4,000				1,000	Conventional
Deep Rock Oil Corp.‡	Cushing, Okla.	12,500				864	Conventional
Elk Refining Co.	Falling Rock, W. Va.	4,000				1,000	Conventional
Esso Standard Oil Co.	Baltimore	42,750				100	Conventional
Esso Standard Oil Co.	Bayonne, N. J.	30,000	2,000	6,000		6,500	Phenol, MEK-ben., acid-clay
Esso Standard Oil Co.	Baton Rouge, La.	245,000	11,000	8,000	3,500	7,500	Phenol, MEK-benzol, propane dewaxing and deasphalting, acid and clay
Freedom-Valvoline Oil Co.	Freedom, Pa.	4,000				800	Conventional
Golden Bear Oil Co.	Bakersfield, Calif.	2,500	500			1,100	Furfural
Gulf Oil Corp.	Philadelphia	107,000	3,000	*1,200		1,100	Duo-Sol
Gulf Oil Corp.	Port Arthur, Tex.	230,000	11,000	3,400 *2,700	4,000 †2,600	12,000	Furfural, phenol, MEK-benzol, propane, Alchlor, Sharples dewax
Humble Oil & Refining Co.	Baytown, Tex.	260,000	8,500	10,000	7,800	12,200	Propane, phenol, MEK-benzol, acid and clay treating
Kendall Refining Co.	Bradford, Pa.	4,800	900	1,200	1,200	1,200	Phenol, propane, pressing
Lion Oil Co.	El Dorado, Ark.	22,000				1,000	Vac. dist. (spec.)
McBride Refining Co.‡	La Blanca, Tex.	2,500				100	Conventional
MacMillan Petroleum Corp.	Norphlet, Ark.	4,500				1,350	Vac. dist. (spec.)
Magnolia Petroleum Co.	Beaumont, Tex.	150,000	9,300	§8,500		5,400	MEK-ben., Duo-Sol, Furfural
Mid-Continent Petroleum Corp.	Tulsa	46,000	5,000	2,500	2,000	5,000	Chlorex, propane
National Refining Co.	Findlay, Ohio	¶9,500				¶600	Acid and clay treatment
Palomar Refining Co.‡	Bakersfield, Calif.	1,300					Vac. dist.
Penna. Refining Co.	Karns City, Pa.	1,500				300	Conventional
Pennzoil Co.	Oil City, Pa.	8,500	1,000	2,250		2,250	Chlorex, MEK-benzol
Phillips Petroleum Co.	Okmulgee, Okla.	8,000				¶1,000	Acid and clay
Phillips Petroleum Co.	Kansas City, Kans.	50,000	3,000	2,000	2,000	1,500	Phenol, propane
Pioneer Oil & Refining Co.	Somerset, Tex.	¶400				¶400	Contact filtration
Premier Oil Refining Co.	Fort Worth	¶8,000				¶700	Conventional
Pure Oil Co.	Cabin Creek, W. Va.	5,500				450	Conventional
Pure Oil Co.	Nederland, Tex.	58,200				2,000	Phenol, MEK, propane
Quaker State Oil Refining Co.	Emlenton, Pa.	2,000	1,680	2,000		1,700	Furfural, MEK-benzol
Quaker State Oil Refining Co.	Farmers Valley, Pa.	4,000	1,680	2,700		2,295	Furfural, MEK-benzol
Quaker State Oil Refining Co.	Oil City, Pa.	2,800				600	Conventional
Quaker State Oil Refining Co.	St. Marys, W. Va.	2,500	680			600	Furfural
Richfield Oil Corp.	Watson, Calif.	91,000				275	Vac. dist., conventional
Shell Oil Co.	Houston	110,000	5,400	3,700	3,800	2,800	Phenol, propane, MEK-benzol, clay and acid
Shell Oil Co.	Martinez, Calif.	45,000	4,880			3,100	Sulfur dioxide, Furfural
Shell Oil Co.	Wood River, Ill.	115,000	3,000	3,600	3,300	3,100	Duo-Sol, propane, acid-clay
Sinclair Refining Co.	East Chicago, Ind.	85,000	5,100	4,750	4,250	2,300	Propane, phenol, MEK-ben.
Sinclair Refining Co.	Houston	85,000	3,500	4,000	4,000	3,233	Propane, phenol, MEK-benzol, acid
Sinclair Refining Co.	Wellsville, N. Y.	9,000		1,500	3,500	2,250	Nitrobenzene, MEK - benzol, contact treating
L. Sonneborn Sons, Inc.	Franklin, Pa.	1,650				500	Conventional
L. Sonneborn Sons, Inc.	Petrolia, Pa.	¶4,000				¶1,000	Conventional
Socony-Vacuum Oil Co., Inc.	Olean, N. Y.	7,000	1,300	1,200		1,200	Chlorex, MEK-benzol
Socony-Vacuum Oil Co., Inc.	Buffalo	22,000				1,000	
Socony-Vacuum Oil Co., Inc.	Paulsboro, N. J.	58,000	7,580	5,300	§5,950	§7,400	MEK-benzol, Duo-Sol, Furfural
Standard Oil Co. of California	Richmond, Calif.	138,000	16,500	5,800		9,000	MEK-benzol, R.P.M., phenol
Standard Oil Co. (Ind.)	Casper, Wyo.	15,200	460			320	Chlorex
Standard Oil Co. (Ind.)	Whiting, Ind.	175,800	3,100	2,200	1,200	1,750	Phenol, propane
Standard Oil Co. (Ind.)	Wood River, Ill.	42,600	1,800	2,350		1,050	Chlorex, propane
Standard Oil Co. (Ohio)	Cleveland	42,500				1,500	Conventional
Standard Oil Co. (Ohio)	Lima, Ohio	30,500				1,800	MEK-Furfural, PDA
Standard Oil Co. (Ohio)	Toledo	21,000				900	Conventional
Sun Oil Co.	Marcus Hook, Pa.	140,000	8,000	4,500		11,800	MEK-benzol, mercury vac. dist., Duo-Sol, Furfural
Texas Co.	Lawrenceville, Ill.	27,000	2,000	¶1,400		¶1,150	Furfural, acetone-benzol
Texas Co.	Port Arthur, Tex.	190,000	18,000	11,000	4,000	16,000	Furfural, sulfur dioxide, MEK-benzol, propane
Three Rivers Refinery‡	Three Rivers, Tex.	1,500				750	Vac. dist., acid and clay
Tide Water Associated Oil Co.	Avon, Calif.	85,000	1,660			1,660	Sulfur dioxide
Tide Water Associated Oil Co.	Bayonne, N. J.	74,000	7,000	3,500	3,400	2,400	Sulfur dioxide, Furfural, MEK-benzol, propane
Union Oil Co. of California	Oleum, Calif.	§69,800	7,200	1,900		1,800	Duo-Sol, phenol, propane, acid and clay
United Refining Co.	Warren, Pa.	5,500				1,400	Semiconventional
Utah Oil Refining Co.	Salt Lake City	24,500				85	Conventional
Waverly Oil Works Co.	Pittsburgh	2,500				580	Conventional
Wolf's Head Oil Refining Co.	Reno, Pa.	2,500				650	Conventional

*Sharples dewaxing. †Alchlor refining. ‡1949 figures. §Under construction. ¶Not operating at present time.

XUM

IMPORTS UP, EXPORTS DOWN FOR FIRST HALF OF 1950

By HENRY D. RALPH

IMPORTS up, exports down—that trend in United States foreign trade in petroleum which has prevailed for several years has continued during 1950. Imports of crude and products currently have been averaging about 220,000 bbl. per day more than a year ago, while exports have been about 100,000 bbl. per day less.

The most spectacular figure in the foreign-trade picture is the increase in imports of products. Imports of products have been about double the rate of the same part of last year, and now account for about 42 per cent of the total.

The bulk of imported products is residual fuel oil. During the first 5 months of the year imports of resid were 95.4 per cent greater than last year; they accounted for 39.4 per cent of the total imports this year compared with 27.6 per cent last year. However, stocks of resid in the United States dropped a total of 20,000,000 bbl. during the first 5 months of this year compared with a decline of only 445,000 bbl. during the same period of 1949, reflecting an increase in industrial demand caused chiefly by the coal strike.

There was also a marked increase in imports of unfinished oils—2,675,000 bbl. during the 5-month period. This classification consists chiefly of topped crude for further refining, and much of it undoubtedly was turned into heavy fuel oil.

Imports of crude have been at a high level all this year, averaging 470,000 bbl. per day, which is 44,000 bbl. per day, or 10.3 per cent, more than during the same part of last year. The biggest supplier was Venezuela, which accounted for 62.5 per cent of our crude imports this year compared with 60.8 per cent last year.

In spite of the big increase in output of crude in the Middle East, imports from that area so far this year have been considerably less than during the same period last year. During the first 5 months of 1950 imports of crude from the Middle East totaled 16,114,000 bbl., or 22.7 per cent of our total imports of crude, whereas during the same part of 1949 they were 18,084,000 bbl., or 28.2 per cent.

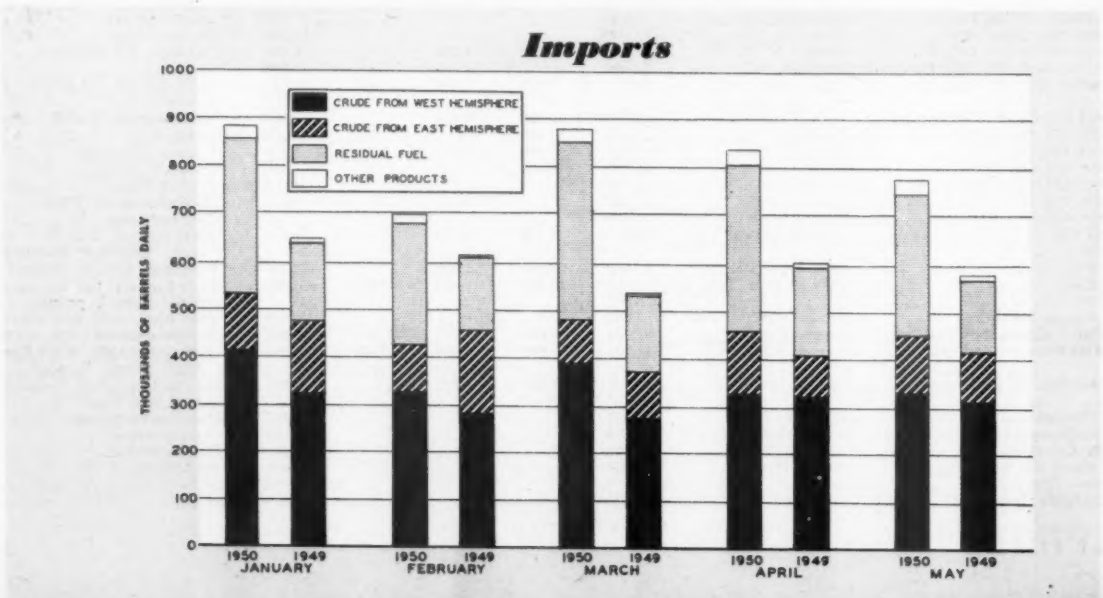
IMPORTS INTO CONTINENTAL UNITED STATES
(Thousands of barrels)

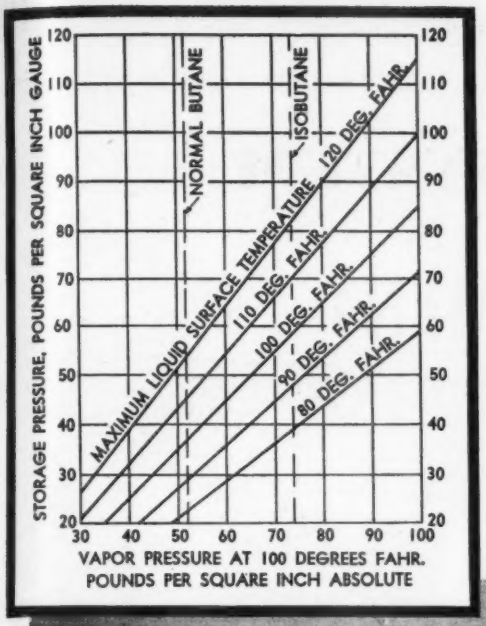
	Jan.-May 1950	Jan.-May 1949	Change
Crude—			
Mexico	3,588	2,648	+ 940
Colombia	6,826	4,232	+ 2,594
Venezuela	44,341	39,044	+ 5,297
Kuwait	10,054	9,178	+ 876
Saudi Arabia	5,821	7,550	— 1,729
Iran and Qatar	239	1,356	— 1,117
Other	108	226	— 118
Total crude	70,977	64,234	+ 6,743
Barrels daily	470	426	+ 44
Products—			
Residual	48,553	24,847	+23,706
Unfinished oils	2,925	250	+ 2,675
Other	925	625	+ 300
Total products	52,403	25,722	+26,681
Barrels daily	817	596	+ 221
Total all oils	123,380	89,956	+33,424
Barrels daily	817	596	+ 221

EXPORTS
(Thousands of barrels)

	Jan.-Apr. 1950	Jan.-Apr. 1949	Change
Commercial exports (including shipments to territories)			
Crude	9,447	9,590	— 143
Gasoline	7,540	15,691	— 8,151
Distillate	4,254	5,642	— 1,388
Residual	4,960	4,081	+ 879
Lube oils	4,524	4,254	+ 270
Other products	2,441	3,751	— 1,310
Total commercial exports	33,166	43,009	— 9,843
Daily average	276	358	— 82
Bunkers laden on ships in foreign trade*	17,950	19,654	— 1,704
Military exports*	7,059	8,375	— 1,316
Total shipments from U. S.	58,175	71,038	—12,863
Daily average	485	592	— 107

*Included in Bureau of Mines domestic demand.



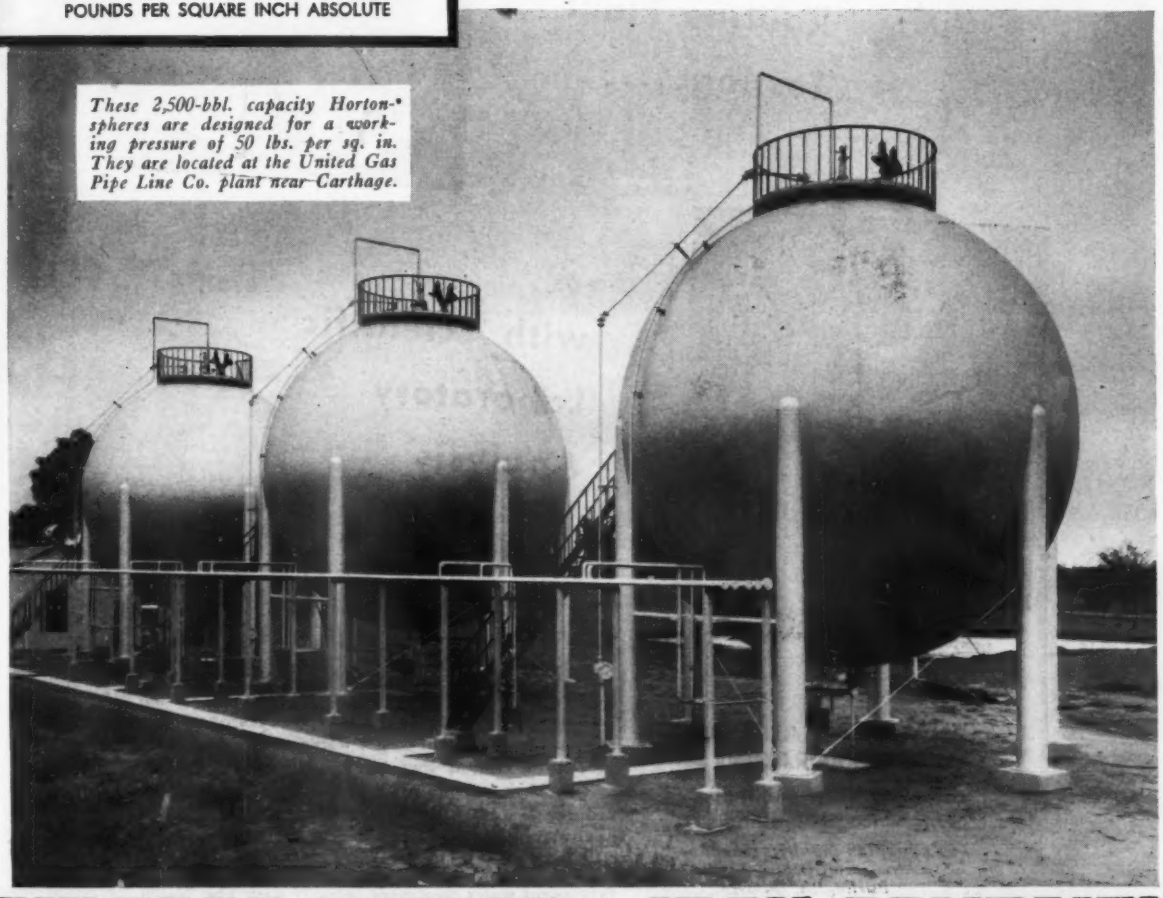


Start here to stop evaporation losses

This chart enables you to determine the pressure for which a tank should be designed to store hydrocarbons with vapor pressures of 30 to 100 lbs. per sq. in. absolute. Locate, at the bottom of the chart, the vapor pressure of the liquid to be stored. Draw a line vertically until it intersects the maximum surface temperature line. Read at either side of the chart the storage pressure required in lbs. per sq. in.

Then turn the job over to Hortonspheres like the ones shown below. These spherical pressure tanks are your best bet for storing butane, butane-propane mixtures, and volatile charging stocks. None of the contents of Hortonspheres is lost as long as the internal pressure does not exceed the setting of the pressure relief valve.

Hortonspheres are available in standard capacities up to 25,000 bbls. for pressure up to 50 lbs. per sq. in. and in smaller capacities for pressures as high as 200 lbs. Write our nearest office for full details about them.



These 2,500-bbl. capacity Hortonspheres are designed for a working pressure of 50 lbs. per sq. in. They are located at the United Gas Pipe Line Co. plant near Carthage.

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Birmingham, 1.....1536 North 50th St.
Boston, 10.....1025—201 Devonshire St.
Chicago, 4.....2128 McCormick Bldg.
Cleveland, 15.....2204 Guildhall Bldg.
Detroit, 26.....1514 Lafayette Bldg.
Havana.....402 Abreu Bldg.
Houston, 2.....2119 National Standard Bldg.
Los Angeles, 17.....1523 General Petroleum Bldg.
New York, 6.....3347—165 Broadway Bldg.
Philadelphia, 3.....1615-1700 Walnut Street Bldg.
Salt Lake City, 4.....525 West 17th South St.
San Francisco, 4.....1554—200 Bush St.
Seattle, 1.....1325 Henry Bldg.
Tulsa, 3.....1606 Hunt Bldg.

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REFINING CAPACITY STILL HEADED UPWARD; MORE PLANTS MODERNIZING

By R. B. TUTTLE

THE OIL AND GAS JOURNAL'S midyear survey of United States and Canadian refinery modernization and expansion projects shows clearly the effect of today's motor-fuel specifications on many medium and some of the large-capacity plants. Despite large increases in catalytic cracking capacity last year, there is still more than 120,000 bbl. of daily capacity now building and in the planning stage. This capacity represents 14 different projects, most of which are just now being started. The majority of these projects are scheduled for completion at the turn of the year although some of them run into middle or late 1951. One of the projects has not yet been started.

In addition to the new catalytic cracking facilities being constructed and scheduled for starting later this year, there are five different projects under way and being readied for conversion of earlier type units to up-to-date plants. There are also two Platforming process projects building and two more in the planning stage. These four projects involve about 7,000 bbl. total daily capacity and are for United States plants.

REFINERY CONSTRUCTION PROJECTS

Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractor
Ashland Oil & Refining Co., Canton, Ohio:				
Increase poly plant, bbl. per day	250	Building	.....	.....
Light-ends recovery unit	.....	Building	.....	.....
Bell Oil & Gas Co., Grandfield, Okla.:				
Platforming unit, bbl. per day	1,500	Building	Late '50	Universal Oil Products Co.
British American Oil Co., Ltd., Edmonton, Alta., Canada:				
New refinery:				
Distillation unit, bbl. per day	5,500	Building	Early '51	Canadian Kellogg, Ltd.
Thermal cracking unit	.....	Building	Early '51	Canadian Kellogg, Ltd.
Coking unit	.....	Building	Early '51	Canadian Kellogg, Ltd.
Cat. cracking unit	.....	Building	Early '51	Canadian Kellogg, Ltd.
Treating unit	.....	Building	Early '51	Canadian Kellogg, Ltd.
California Refining Co., Perth Amboy, N. J.:				
Cat. cracking unit, bbl. per day	25,000	Building	Early '51	Houdry Process; C. F. Braun
U.O.P. reforming unit, bbl. per day	10,000	Building	Early '51	C. F. Braun & Co.
Alkylation unit, bbl. per day	5,000	Building	Early '51	M. W. Kellogg Co.
Crude-oil units, bbl. per day	50,000	Building	Early '51	C. F. Braun & Co.
Gasoline-treating units, bbl. per day	20,000	Building	Early '51	Catalytic Construction Co.
Boiler plants, lb. per hr.	300,000	Building	Early '51	C. F. Braun & Co.
Cities Service Oil Co. (Del.), Cicero, Ill.:				
Lube-oil-compound plant, bbl. per day	1,200	Building	July '50	Sumner S. Sollitt & Co.
Cities Service Oil Co. (Pa.), Linden, N. J.:				
Vacuum distillation unit, bbl. per day	3,600	Planned	.....	.....
Cities Service Refining Corp., Lake Charles, La.:				
Revise feed-water treater	.....	Building	Sept. '50	.....
Deep Rock Oil Corp., Cushing, Okla.:				
Cat. cracking unit, bbl. per day	5,000	Building	July '50	U.O.P.; Jones & Laughlin
Water-cooling system, g.p.m.	17,000	Building	July '50	Brown Lite Co.
Girbotol unit, bbl. per day	600	Building	Aug. '50	J. F. Pritchard & Co.
Crude-oil unit, bbl. per day	4,500	Building	July '50	Refinery Engineering Co.
Modernize and enlarge refinery office	.....	Building	Sept. '50	Austin Co.
Derby Oil Co., Wichita, Kans.:				
Cat. cracking unit	.....	Planned	.....	.....
Excelsior Refineries, Ltd., Lloydminster, Alta, Canada:				
Vacuum reduction unit, bbl. per day	2,000	Building	Aug. '50	Koch Engineering Co.
Farmers Union Central Exchange, Laurel, Mont.:				
New office and lab. building	.....	Building	Aug. '50	.....
Frontier Refining Co., Cheyenne, Wyo.:				
Thermal cracking unit, bbl. per day	2,400	Building	Aug. '50	Refinery Engr. Co.; U.O.P.
General Petroleum Corp., Torrance, Calif.:				
H_2S and NH_3 recovery facilities, tons per day	3 and 10	Building	.....	The Fluor Corp.
Cat. poly plant, bbl. per day	500	Planned	Early '51	.....
Imperial Oil, Ltd., Winnipeg, Man., Canada:				
New refinery, bbl. per day	10,000	Building	July '51	U.O.P.; Canadian Kellogg Co.
Indiana Farm Bureau Coop Assn., Mount Vernon, Ind.:				
Cat. cracking unit, bbl. per day	4,000	Building	Nov. '50	Universal Oil Products Co.
Vacuum unit, bbl. per day	3,500	Building	Nov. '50	Universal Oil Products Co.
Revamp poly unit, bbl. per day	300	Building	Nov. '50	Universal Oil Products Co.
Johnson Oil Refining Co., Cleveland, Okla.:				
Platforming unit, bbl. per day	1,800	Planned	Late '50	.....
Kendall Refining Co., Bradford, Pa.:				
Platforming unit, bbl. per day	1,500	Authorized	Late '50	Universal Oil Products Co.
Louisville Refining Co., Louisville, Ky.:				
Cat. cracking unit, bbl. per day	3,000	Planned	.....	.....
Magnolia Petroleum Co., Beaumont, Tex.:				
Convert two Houdry units to T.C.C.	.....	Building	Late '50	.....
Convert one Houdry unit to T.C.C.	.....	Authorized	Early '51	.....
McColl-Frontenac Oil Co., Ltd., Edmonton, Alta., Canada:				
New refinery: Crude-distillation, bbl. per day	5,500	Building	Early '51	Foster Wheeler, Ltd.
Cat. cracking unit and coking unit	.....	Building	Early '51	Foster Wheeler, Ltd.
McMurrey Refining Co., Tyler, Tex.:				
Cat. cracker and auxiliaries, bbl. per day	6,000	Building	Mar. '51	U.O.P.; Refinery Engr. Co.
Mexican Petroleum Corp., Wilmington, N. C.:				
Alphalt plant, bbl. per day	2,000	Planned	.....	.....

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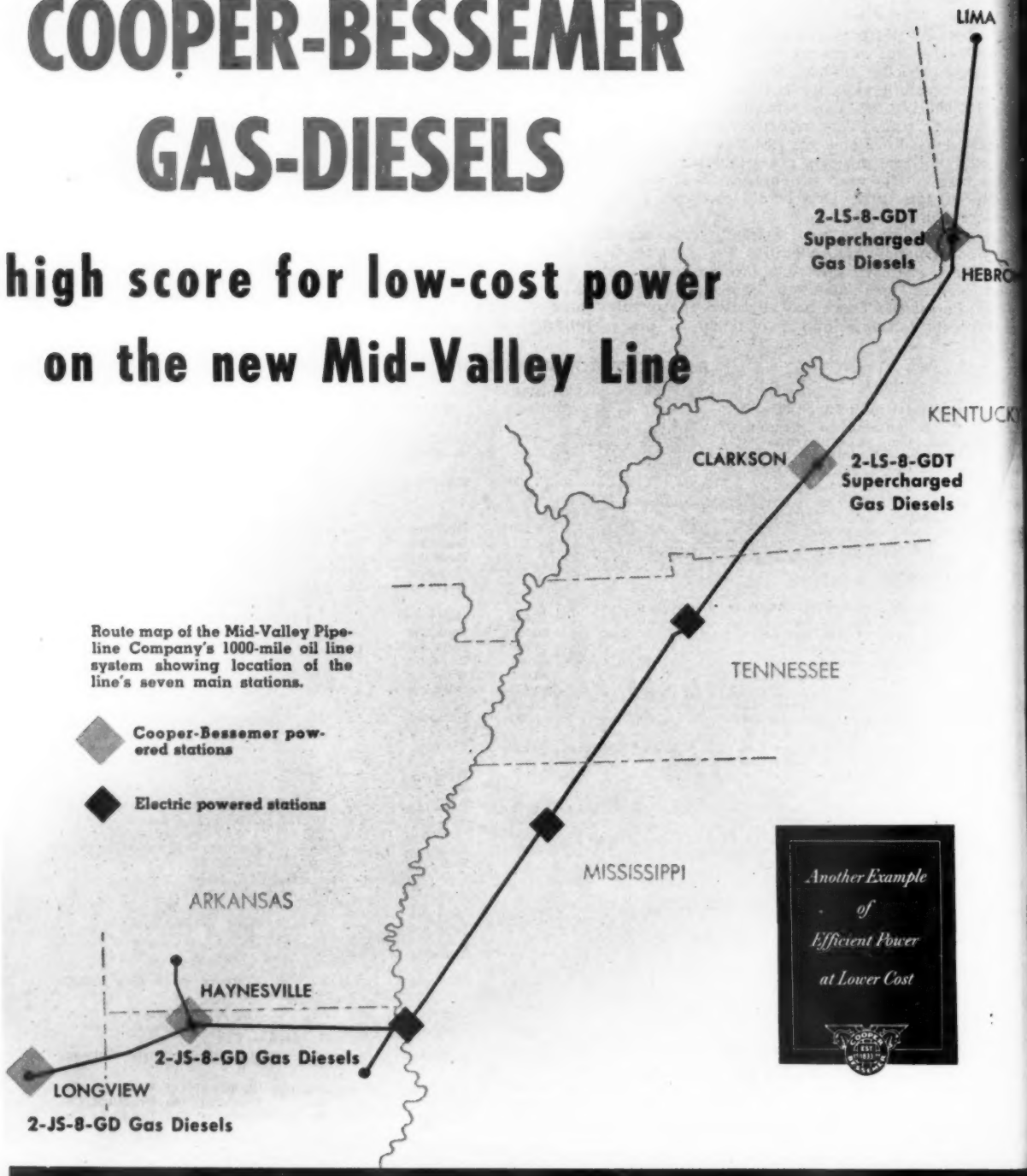
COOPER-BESSEMER GAS-DIESELS

high score for low-cost power on the new Mid-Valley Line



Route map of the Mid-Valley Pipeline Company's 1000-mile oil line system showing location of the line's seven main stations.

Cooper-Bessemer powered stations

Electric powered stations

Another Example of Efficient Power at Lower Cost

GAS · DIESEL · GAS-DIESEL ENGINES

New York Washington Bradford, Pa. Parkersburg, W. Va. San Francisco, Cal. Seattle, W

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● B. F. Relf of Mid-Valley checking a supercharged LS-8 gas-diesel, rated 1715 hp at 327 rpm on the Cooper-Bessemer erection floor. Mid-Valley's Clarkson and Hebron stations in Kentucky will each be powered by two of these modern engines.

● C. N. Brindley of Mid-Valley checking a JS-8 gas-diesel, rated 800 hp at 450 rpm on the Cooper-Bessemer erection floor. Units of this type will power Mid-Valley's Longview, Texas, and Haynesville, La., stations—two engines for each station.

WHEN put into operation this Fall, Mid-Valley will be the most modern, most economical of the nation's cross-country oil lines. Highly significant, thorough studies proved that a combination of four gas-diesel powered stations and three electric powered stations assured peak economy. Modern, exceptionally efficient Cooper-Bessemer gas-diesels were picked for the job, will be located as shown on the map.

The smooth operation of Cooper-Bessemer gas-diesels on oil or any combination of gas and oil, means maximum flexibility and uninterrupted service. Even if the gas supply fails completely, these engines will continue to run, fueled by oil bled from the line.

If you have power needs coming up, you'll be wise to check into Cooper-Bessemer's latest money-saving engine developments—such as supercharged gas engines and gas-diesels . . . new gains in the power-to-space ratio of oil-burning diesels . . . and supercharged Turboflow compressor engines. Just get in touch with the nearest Cooper-Bessemer office.

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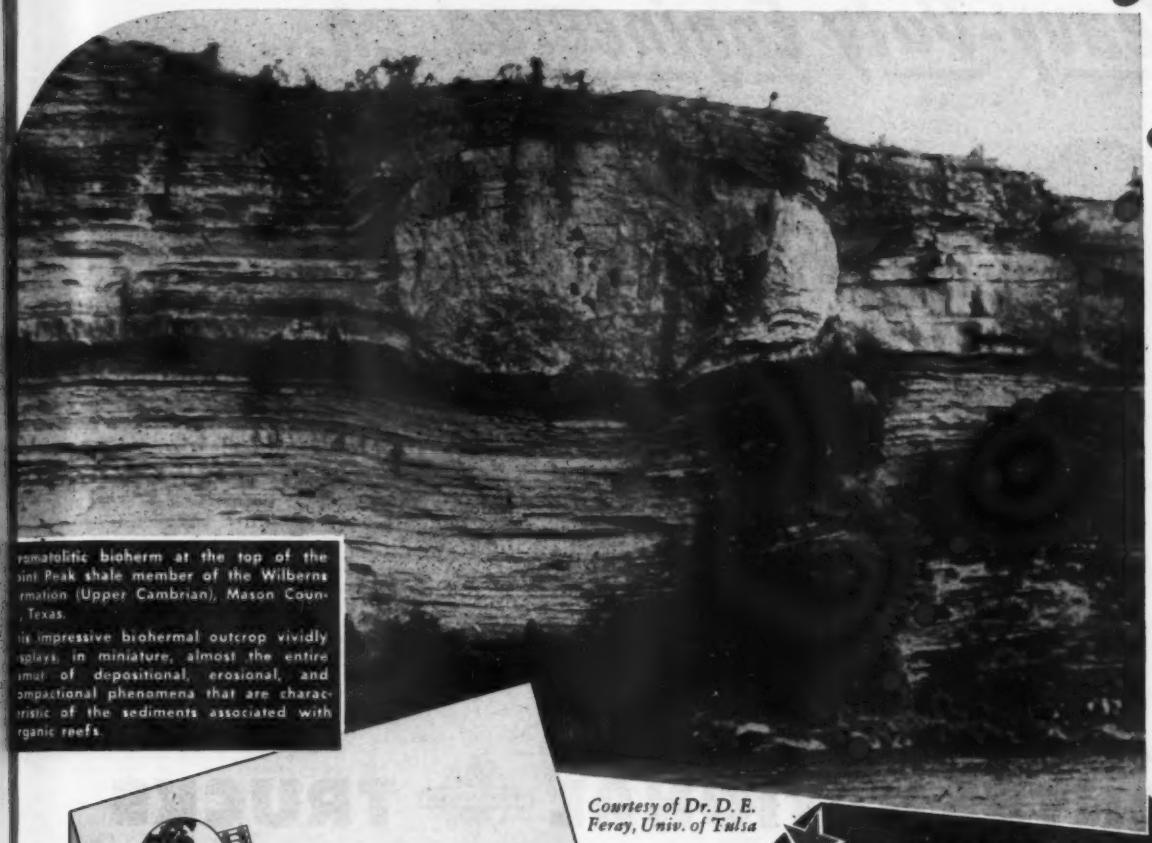
REFINERY CONSTRUCTION PROJECTS (Continued)

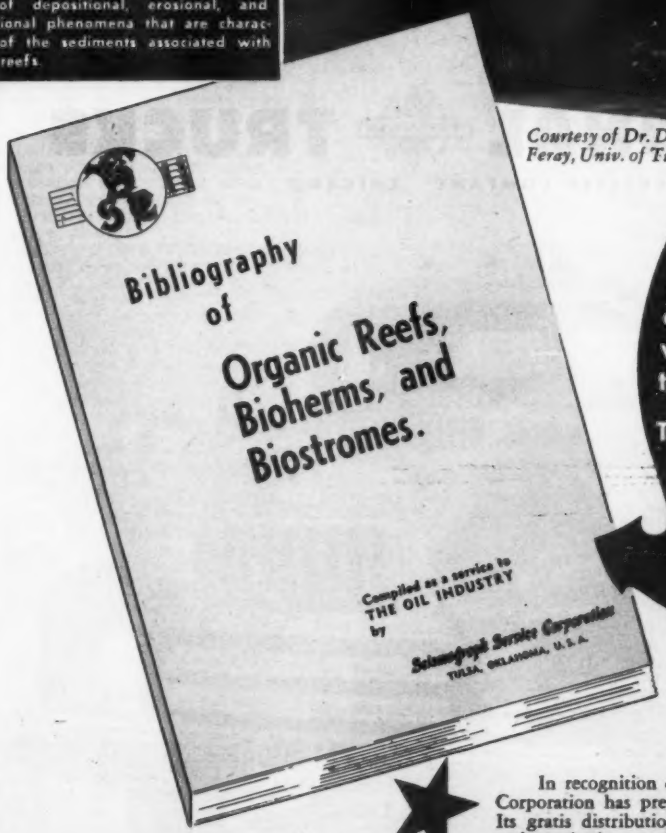
Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractor
National Coop. Refinery Assn., McPherson, Kans.:				
Cat. cracking unit, bbl. per day	9,820	Building	Apr. '51	U.O.P.; Refinery Engr. Co.
Cat. poly unit, bbl. per day	880	Building	Sept. '50	U.O.P.; Refinery Engr. Co.
Compressor capacity, hp.	1,720	Building	Apr. '51	U.O.P.; Refinery Engr. Co.
Increase crude-oil unit, bbl. per day	23,200	Building	Apr. '51	U.O.P.; Refinery Engr. Co.
Feed-stock unit for cat. cracker, bbl. per day	10,650	Building	Apr. '51	U.O.P.; Refinery Engr. Co.
Modify thermal cracker, bbl. per day	2,940	Building	Apr. '51	U.O.P.; Refinery Engr. Co.
Modify treating facilities	.....	Building	Apr. '51	U.O.P.; Refinery Engr. Co.
Storage, bbl.	80,000	Authorized	Apr. '51	Graver
New Mexico Asphalt & Refining Co., Artesia, N. M.:				
Revise thermal cracker, bbl. per day	2,500	Building	Aug. '50	Refinery Engineering Co.
Onyx Refining Co., Abilene, Tex.:				
Increase crude-oil unit, bbl. per day	4,500	Planned	.....	.....
Pan-Am Southern Corp., El Dorado, Ark.:				
Delayed-coking unit, bbl. per day	9,300	Building	Oct. '50	The Lummus Co.
Cat. cracking unit, bbl. per day	7,000	Building	Apr. '51	Foster Wheeler Corp.
Panhandle Producing & Refining Co., Wichita Falls, Tex.:				
Install boiler, hp.	310	Building	Aug. '50	.....
Revamp poly unit	.....	Building	.....	.....
Pennzoil Co., Rouseville, Pa.:				
Propane deresining plant	.....	Building	.....	M. W. Kellogg Co.
Peppers Refining Co., Oklahoma City, Okla.:				
Cat. reforming unit, bbl. per day	1,000	Building	Early '51	Perco; Koch Engineering Co.
Cat. poly unit	.....	Building	Early '51	Koch Engineering Co.
Phillips Oil Co., Phillips, Tex.:				
Cat. cracker and auxiliaries, bbl. per day	30,000	Building	Sept. '51	C. F. Braun & Co.
Premier Petroleum Co., Fort Worth, Tex.:				
Revamp topping unit, bbl. per day	4,000	Planned	Late '50	.....
Revamp thermal cracker, bbl. per day	1,600	Planned	Late '50	.....
Republic Oil Refining Co., Texas City, Tex.:				
Repair thermal cracker, bbl. per day	8,000	Building	.....	.....
Salt Lake Refining Co., Salt Lake City:				
Cat. cracking unit, bbl. per day	10,000	Building	Late '50	Bechtel Corp.
Saskatchewan Federated Coop, Ltd., Regina, Sask., Canada:				
Refinery capacity increase, bbl. per day	3,000	Building	Late '50	Born Engineering Co.
Shallow Water Refining Co., Shallow Water, Kans.:				
Poly unit, bbl. per day	150	Building	Late '50	Koch Engineering Co.
Shamrock Oil & Gas Corp., Sunray, Tex.:				
Vacuum reduction unit, bbl. per day	2,000	Building	Late '50	Koch Engineering Co.
Houdriflow unit, bbl. per day	5,900	Building	Early '50	Catalytic Construction Co.
Shell Oil Co. of Canada, Ltd., Montreal, Que., Canada:				
Revamp topping units, bbl. per day	30 000	Building	Aug. '50	The Fluor Corp.
Cat. cracking unit, bbl. per day	10,000	Building	Nov. '50	Arthur G. McKee Co.
Feed-preparation unit	.....	Building	Nov. '50	Arthur G. McKee Co.
Gas-recovery unit	.....	Building	Nov. '50	Arthur G. McKee Co.
Light-ends treating unit	.....	Building	Nov. '50	Arthur G. McKee Co.
Cat. poly plant, bbl. per day	1,100	Building	Nov. '50	The Fluor Corp.
Shell Oil Co., Wood River, Ill.:				
Asphalt-loading facilities	.....	Building	Aug. '50	The Fluor Corp.
Sioux Oil Co., Newcastle, Wyo.:				
Thermal cracker, bbl. per day	2,000	Building	July '50	Koch Engineering Co.
Cat. poly unit	.....	Building	July '50	Koch Engineering Co.
Socony-Vacuum Oil Co., Inc., Buffalo, N. Y.:				
Cat. cracking unit, bbl. per day	15,000	Building	1951	Bechtel Corp.
Polymerization plant	.....	Building	1951	Bechtel Corp.
Expand gas-recovery facilities	.....	Building	1951	Bechtel Corp.
Socony-Vacuum Oil Co., Inc., Trenton, Mich.:				
Convert Houdry to T.C.C. unit, bbl. per day	15,000	Building	Late '50	C. F. Braun & Co.
Socony-Vacuum Oil Co., Inc., Augusta, Kans.:				
Convert Houdry to T.C.C. unit, bbl. per day	15,000	Building	Late '50	The Fluor Corp.
Socony-Vacuum Oil Co., Inc., Paulsboro, N. J.:				
Naphtha reformer, bbl. per day	12,000	Authorized	May '51	C. F. Braun & Co.
Standard Oil Co. of British Columbia, Burnaby, B. C., Canada:				
Fuel-oil storage, bbl.	5,800	Planned	.....	.....
Stove-oil storage, bbl.	20,000	Planned	.....	.....
Standard Oil Co. of California, Richmond, Calif.:				
Convert T.C.C. to Houdriflow unit	.....	Building	.....	.....
Install new vacuum tower, bbl. per day	50,000	Building	1951	.....
Standard Oil Co. (Ohio), Lima, Ohio:				
M.E.K. unit, bbl. per day	2,500	Building	July '50	The Lummus Co.
Furfural unit, bbl. per day	3,300	Building	July '50	The Lummus Co.
Clay contact unit, bbl. per day	1,800	Building	July '50	The Lummus Co.
Standard Oil Co. (Ohio), Cleveland:				
Cat. cracking unit, bbl. per day	18,000	Building	Dec. '50	Bechtel Corp.
Crude units	.....	Planned	.....	.....
Sun Oil Co., Marcus Hook, Pa.:				
Packaging plant	.....	Building	Sept. '50	W. W. Lindsay Co.
The Texas Co., Lawrenceville, Ill.:				
Expand refinery, bbl. per day	20,000	Building	Apr. '51	Foster Wheeler; M. W. Kellogg
Atmospheric topping unit	.....	Building	Apr. '51	Foster Wheeler; M. W. Kellogg
Vacuum pipe still	.....	Building	Apr. '51	Foster Wheeler; M. W. Kellogg
Cat. cracking unit	.....	Building	Apr. '51	Foster Wheeler; M. W. Kellogg
Cat. poly unit	.....	Building	Apr. '51	Foster Wheeler; M. W. Kellogg
Union Oil Co. of California, Brea, Calif.:				
Research facilities	.....	.....	.....	P. J. Walker; Austin, Field & Fry
Wisconsin Oil Refining Co., Sheboygan, Wis.:				
Additional crude-distillation unit, bbl. per day	5,000	Planned	.....	.....
Platforming unit, bbl. per day	2,000	Planned	.....	.....
Wolf's Head Oil Refining Co., Reno, Pa.:				
Increase shipping facilities	.....	Planned	.....	.....

ARE YOU LOOKING FOR *Reefs*.



romatolitic bioherm at the top of the
oint Peak shale member of the Wilberns
rmation (Upper Cambrian), Mason Coun-
, Texas.
is impressive biohermal outcrop vividly
splays, in miniature, almost the entire
mut of depositional, erosional, and
ompactional phenomena that are charac-
eristic of the sediments associated with
rganic reefs.

Courtesy of Dr. D. E. Feray, Univ. of Tulsa



THE GEOLOGIST TAKES A NEW LOOK

The recent realization of the importance of organic reefs in the accumulation of petroleum has opened up broad, new vistas in the application of geology to the discovery of future oil reserves.

THE SEISMOLOGIST TAKES A NEW LOOK

The successful resolution of seismic data in possible reef areas involves, first, a thorough knowledge of the fundamentals of reef origin, occurrence, and characteristics.

In recognition of the above *facts*, Seismograph Service Corporation has prepared this comprehensive bibliography. Its gratis distribution is another example of SSC's unique and continuing service to the Oil Industry.

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INFORMATION on the current status of the natural-gas-processing industry's expansion program is given in the following table. These data, obtained via The Oil and Gas Journal's midyear survey, directly from operating and engineering companies, represent active projects as of the third quarter of this year.

Some of the new plants are very much in the "big" category. Currently, seven new natural-gasoline-plant projects account for about 320,000,000 cu. ft. of daily input capacity. Three of these large projects, scheduled for completion late in this year or in early 1951, are now being built. Two more of the projects have been authorized but are not yet under construction.

Around 185,000,000 cu. ft. of additional gas capacity will result from expansion of existing facilities in six different gasoline plants during the remainder of the year. One plant, designed to operate in special extraction service, is yet to be built. This plant, rated at 600,000,000 cu. ft. of gas per day, is to be installed in Kentucky and will be operated by one of the major gas-transportation companies.

Another plant is also scheduled for erection in Kentucky. This plant (Mathieson) estimated to cost in the neighborhood of $20,000,000, will produce petrochemicals. Completion of the plant is scheduled for next year.

GASOLINE-PLANT AND PETROCHEMICAL CONSTRUCTION PROJECTS

Company, location and type of project—	Capacity rating	Status	Comp. schedule	Contractor
American Republics Corp., Tyler County, Texas:				
Convert plant from compression to absorption, cu. ft. per day	15,000,000	Building	July '50	Gasoline Plant Const. Corp.
Arkansas Fuel Oil Co., Ruston, La.:				
Gasoline plant, cu. ft. per day	50,000,000	Building	Late '50	.....
Arkansas Fuel Oil Co., Carthage, Tex.:				
Increase plant capacity, cu. ft. per day	50,000,000	Building	Early '51	.....
Bolin Trust Co., Wichita County, Texas:				
Gas injection unit	.....	Authorized	.....	.....
Chicago Corp. and Pontiac Refining Corp., Corpus Christi, Tex.:				
New petrochemical plant	.....	Planned	.....	.....
Continental Oil Co., Ventura County, California:				
Gasoline plant, cu. ft. per day	23,000,000	Building	Aug. '50	Refinery Maintenance Co., Inc.
Del Rey Petroleum Co., Chesterville, Tex.:				
Increase plant capacity, cu. ft. per day	60,000,000	Building	Oct. '50	O. L. Olsen
Tank-car loading rack	.....	Building	July '50	O. L. Olsen
Dow Chemical Co., Freeport, Tex.:				
Increase petrochemical facilities	.....	Building	.....	.....
Dow Chemical Co., Midland, Mich.:				
Increase petrochemical facilities	.....	Building	.....	.....
Kirk Pool Op. Comm., Eastland County, Texas:				
Gasoline plant	.....	Planned	.....	.....
La Gloria Corp., Jim Wells County, Texas:				
Additional compression, cu. ft. per day	4,000,000	Building	Late '50	.....
Lion Oil Co., Scurry County, Texas:				
Gasoline plant	.....	Planned	.....	.....
Mathieson Hydrocarbon Chemical Corp., Brandenburg, Ky.:				
Petrochemical plant	.....	Authorized	.....	.....
Northern Natural Gas Co., Mullinville, Kans.:				
Addition to compressor station, hp.	3,200	Building	Oct. '50	The Fluor Corp.
Panhandle Eastern Pipe Line Co., Liberal, Kans.:				
Expand gasoline plant, cu. ft. per day	20,000,000	Planned	.....	.....
Pecos Petroleum Co., Orla, Tex.:				
Plant expansion, gal. per day	30,000	Building	Aug. '50	O. L. Olsen
Shell Oil Co., Elk City, Okla.:				
Gasoline plant, cu. ft. per day	100,000,000	Building	Late '50	Refinery Maintenance Co., Inc.
Skelly Oil Co., Skellytown, Tex.:				
Rebuild gasoline plant, cu. ft. per day	12,000,000	Building	Early '51	J. E. Carlson, Inc.
Standard Oil Co. of Texas, Snyder, Tex.:				
Gasoline plant, cu. ft. per day	20,000,000	Building	Late '50	.....
Stanolind Oil & Gas Co., Elk Basin, Wyo.:				
Winterize gasoline plant	.....	Building	Sept. '50	Refinery Engneeiring Co.
Stanolind Oil & Gas Co., Nueces County, Texas:				
Increase gasoline plant, cu. ft. per day	5,000,000	Planned	.....	.....
Sunray Oil Corp., Scurry County, Texas:				
Gasoline plant, cu. ft. per day	50,000,000	Authorized	Early '51	.....
Superior Oil Co., Colorado County, Texas:				
Gasoline plant, cu. ft. per day	70,000,000	Planned	.....	.....
Tennessee Gas Transmission Co., Greensburg, Ky.:				
Extraction plant, cu. ft. per day	600,000,000	Authorized	Late '50	.....
Texas Gas Transmission Co., Bastrop, La.:				
Add compressor capacity, hp.	8,800	Building	Sept. '50	The Fluor Corp.
Texas Gas Transmission Co., Clarksdale, Miss.:				
Add compressor capacity, hp.	8,000	Building	Sept. '50	The Fluor Corp.
Tide Water Associated Oil Co., Anderson County, Texas:				
Convert cycling plant to gasoline plant, cu. ft. per day	25,000,000	Building	Aug. '50	.....
Tide Water Associated Oil Co., Venice field, Louisiana:				
Booster station and gathering system, cu. ft. per day	20,000,000	Authorized	Sept. '50	Brown & Root
Warren Petroleum Corp., Maysville, Okla.:				
Extend gathering system, cu. ft. per day	40,000,000	Authorized	.....	.....
Warren Petroleum Corp., Holliday, Tex.:				
Increase fractionation facilities	.....	Planned	.....	.....
Wyoming Pipe Line Co., Casper, Wyo.:				
Dehydration plant, bbl. per day	20,000	Building	Mid '50	Refinery Engineering Co.

XUM

9,000 MILES OF LINES NOW BUILDING IN ALL PARTS OF WORLD

by WILLIAM P. STEINE

MORE than 9,000 miles of crude, products, and natural-gas lines are now under construction throughout the world, and, with a total of more than 40,000 miles of lines planned for the future, all records undoubtedly will be broken this year, with an expected total of between 15,000 and 20,000 miles being actually laid before 1951.

Of this 9,000-mile total, more than 6,000 miles are in the United States, the larger portion of which are natural-gas lines.

At the middle of the year more than 5,000 miles of line had been laid in the United States, including 1,600 miles of crude lines, 1,500 miles of products lines, and 2,500 miles of natural-gas lines.

More than 24,500 miles of lines are planned for construction in this country in the future, including 1,600 miles of crude lines, 500 miles of products lines, and 22,500 miles of natural-gas lines.

Elsewhere in the world, a total of approximately 3,000 miles of lines are now under way, with plans calling for more than 7,500 miles to be laid in the future.

The major portion of pipe-line activity lies in the natural-gas industry. Many huge projects have either been started, or completed, or are planned for the future. Major projects include: Transcontinental Gas Pipe Line Corp.'s Texas-to-New York line; Trunkline Gas Supply Co.'s Texas-to-Illinois line (which recently was approved by Federal Power Commission); Texas Illinois Gas Pipe Line Co.'s Texas-to-Illinois line, which also was approved by FPC; Panhandle-Eastern Pipe Line Co.'s big expansion program, approved in conjunction with Trunkline's project; Valley Gas Pipe Line Co., which is proposing to construct an artery from South Texas to Michigan; and others.

Highlighting construction this year along with Transco's project are the crude-oil line of Mid-Valley Pipe Line Co. (Sun and Sohio) which runs from Texas to Ohio, and Interprovincial Pipe Line Co.'s crude-oil line from Edmonton, Alta., Canada, to Superior, Wis. The outstanding crude-oil project is Trans-Arabian Pipe Line Co.'s 1,067-mile, 30-31-in. from the Persian Gulf area to Sidon, Lebanon.

The following tables give detailed information on the principal projects planned and under way, and lines completed so far in 1950.

TABLE 1—PRINCIPAL DOMESTIC CRUDE-OIL PIPE-LINE PROJECTS UNDER WAY AND PLANNED

Company—	Miles	Inch	Status	Contractor, location, and completion date
Arizona Pipe Line Co.	600	8	Proposed	Permian basin to Phoenix.
Gulf Refining Co.	72	6	Under way	Pipeline Service Co.—El Dorado, Kans., to Webb City, Okla.
Gulf Refining Co.	20	8-10	Under way	Latex Const. Co.—Roscoe to Snyder pool in Scurry County, Texas.
Humble Pipe Line Co.	31	8	Proposed	Fort Chadbourne to Ballinger, Runnels County, Tex.
Lakehead Pipe Line Co., Inc.†	360	18	Contracted	Anderson Bros.—Gretna to Superior, Wis.
Magnolia Pipe Line Co.	49	12	Under way	Bishop & Lock Const.—Colorado City to Hillsboro, Tex.
Magnolia Petroleum Co.	60	4-24	Under way	Henry L. Lemons & Co.—Gathering system in La Ward and Lolita fields, Texas.
Mid-Valley Pipe Line Co.	41	20	Contracted	Latex Const.—Haynesville to Red River near Benton, La.
Mid-Valley Pipe Line Co.	105	22	Under way	Houston Contracting—Oakland, Miss., to Henderson, Tenn., 7-31-50.
Mid-Valley Pipe Line Co.*	1,053	20-22	Under way	O. R. Burden, Sec. 1—Longview, Tex., to Mayersville, Miss.; Covington, Ky., to Lima, Ohio.
Mid-Valley Pipe Line Co.	68	20	Under way	Latex Const.—Sec. 2, Longview, Tex., to Dixie, La., 8-1-50.
Mid-Valley Pipe Line Co.	126	20	Under way	Associated Pipe Line Const.—Sec. 3A, Haynesville, La., to Mayersville, Miss.
Mid-Valley Pipe Line Co.	111	22	Under way	Mayersville to near Charleston, Miss.
Mid-Valley Pipe Line Co.	111	22	Under way	Eastern Const., Inc.—Sec. 3B-4A, Oakland, Miss., to Henderson, Tenn.
Mid-Valley Pipe Line Co.	155	22	Under way	Eastern Const.—Sec. 4B-5A, Henderson to Clarksville, Tenn.
Mid-Valley Pipe Line Co.	111	20	Under way	Britton Const. Co.—Sec. 5B-6A, Clarksville, Tenn., to Elizabethtown, Ky.
Mid-Valley Pipe Line Co.	89	22	Under way	H. L. Gentry Const.—Sec. 6B, Hebron to Mount Washington, Ky., 9-49.
Mid-Valley Pipe Line Co.	129	20	Under way	Mahoney Contr. Co.—North of Ohio River to Lima, Ohio.
Mid-Valley Pipe Line Co.	124	20	Under way	Britton Const. Co.—Sec. 7, Hebron, Ky., to Eaton, to Lima, Ohio.
Pan-American Pipe Line Co.	80	10	Under way	From southern part of Scurry County, Texas., to a connection with Humble Pipe Line Co. line near San Angelo, Tex.
Pelican Oil Co.	60	6	Under way	Lake Charles, La.
Phillips Pipe Line Co.	25	8	Considered	Loops between Thrall and Kansas City, Kans.
Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.)*	236	18	Contracted	Portland, Me., to Montreal, Que., Canada.
Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.)	85	18	Under way	Oklahoma Contr.—Sec. 1, Portland, Me., to Gorham, N. H.
Portland Pipe Line Co. (Montreal Pipe Line Co., Ltd.)	85	18	Contracted	Associated P. L. Contr.—Sec. 2, Gorham, N. H., to international boundary near North Troy, Vt.
Richfield Oil Corp.	40	10	Planned	Bechtel Corp., (Somastic)—Cuyama Valley to Newhall, Calif.
Socony-Vacuum Oil Co., Inc.	122	8	Considered	Big Horn Basin to Casper, Wyo.

*Total mileage of project, details of which are given in items in this table. †Subsidiary of Interprovincial Pipe Line Co., Canada.

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Other INTERCHANGEABLE buckets include ¾ cu. yd. Narrow Bucket; 2 cu. yd. Light Materials Bucket; 1 cu. yd. Rock Bucket. Teeth available for all buckets. Tractor Weight, 11,250 lb. (bare) . . . 40.26 drawbar hp.

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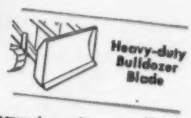
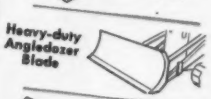
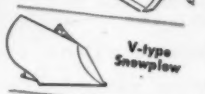
◀ **HD-5G With INTERCHANGEABLE Crane Hook. Lifting capacity—5,000 lb.**

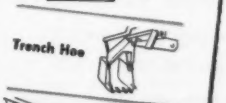
HD-5G With INTERCHANGEABLE Lift Fork. Lifting capacity—4,000 lb. ▶

other INTERCHANGEABLE attachments include:









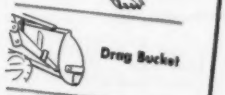


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TABLE 2—PRINCIPAL DOMESTIC PRODUCT PIPE-LINE PROJECTS UNDER WAY AND PLANNED

Company—	Miles	Inch	Status	Contractor, location, and completion date
Connecticut Pipe Line Co.†	40	6	Planned	New Haven to Hartford, Conn.
Great Lakes Pipe Line Co.*	1,296	12	Under way	Looping from Tulsa north.
Great Lakes Pipe Line Co.	47	12	Contracted	Midwestern Constructors, Inc.—Sec. 23, between Atchison, Kans., and Falls City, Neb.
Great Lakes Pipe Line Co.	47	12	Contracted	Midwestern Constructors.—Sec. 24, between Falls City and Nebraska City, Neb.
Great Lakes Pipe Line Co.	48	12	Contracted	Midwestern Constructors.—Sec. 25, between Nebraska City and Omaha.
Great Lakes Pipe Line Co.	45	12	Under way	Trojan Const.—Irvington to Decatur, Neb.
Great Lakes Pipe Line Co.	41	12	Under way	A. C. Holder Const.—Decatur, Neb., to Sioux City, Iowa.
Great Lakes Pipe Line Co.	38	12	Planned	Sioux City to Hawarden, Iowa.
Great Lakes Pipe Line Co.	39	12	Planned	Hawarden to Sioux Falls, S. D.
Great Lakes Pipe Line Co.	73	12	Under way	Trojan Const.—Kansas City, Mo., northward through Platte, Clay, Clinton, DeKalb and Daviess counties, Missouri.
Great Lakes Pipe Line Co.	37	12	Under way	Brodie Const. Co.—South of Bethany, across Iowa line.
Great Lakes Pipe Line Co.	355	12	Authorized	Kansas City through Omaha and Sioux City, Iowa, to Sioux Falls, S. D.
Great Lakes Pipe Line Co.	37	12	Under way	R. H. Fulton.—Osceola to Des Moines, Iowa.
Great Gates Pipe Line Co.	....	..	.....	R. H. Fulton.—Kansas and Missouri River crossings.
Great Lakes Pipe Line Co.	41	12	Under way	A. C. Holder Const.—Sioux City, Iowa, to Missouri River crossing at Decatur, Neb., 7-15-50.
Great Lakes Pipe Line Co.	100	12	Under way	Sheehan Pipe Line Const.—St. Paul to Faribault, Minn., state line to Faribault, Minn.
Phillips Petroleum Co.	118	3-26	Under way	D. D. Vaughn.—Gas-gathering system; Sherman and Hansford counties, Texas.
Phillips Petroleum Co. and Shamrock Oil & Gas Co.	155	6	Planned	Extension on 600-mile line at Phillips, Tex.-LaJunta to Denver.
Pure Transportation Co.	100	6	Proposed	Heath to Dayton, Ohio.
Salt Lake Pipe Line Co.	63	8	Under way	Oklahoma Contr.—Mountain Home to Boise, Idaho.
Salt Lake Pipe Line Co.	140	8	Contracted	Bechtel Corp.—Boise to Baker, Idaho.
Salt Lake Pipe Line Co.	120	6-8	Under way	Pacific Pipeline & Engineers, Ltd.—Baker, Ore., to Pasco, Wash., 8-8-50.
Standard Oil Co. (Ohio)	38	8	Authorized	Toledo to Fostoria, Ohio.

*Complete project. †Deferred.

TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PIPE-LINE PROJECTS UNDER WAY AND PLANNED

Alabama-Tennessee Natural Gas Co.	76	10	Under way	Lehman-Hoge & Scott.—Selmer, Tenn., to Muscle Shoals, Ala.
Algonquin Gas Transmission Co.	276	..	Proposed	Lambertville, N. J., to Boston area.
Algonquin Gas Transmission Co.	492	..	Proposed	Laterals—New England area.
Alabama-Tennessee Natural Gas Co.	35	8	Authorized	Muscle Shoals to Decatur, Ala.
Arkansas-Louisiana Gas Co.	163	20	Authorized	Wascom gas field, Texas., to Hot Springs County, Arkansas.
Arkansas-Louisiana Gas Co.	69	20	Under way	Anderson Bros.—Waskom, Tex., to Magnolia, Ark.
Atlantic Gulf Gas Co. (United Gas Pipe Line Co.)	1,530	..	Planned	Alabama-Florida-Georgia-South Carolina.
Central Hudson Gas & Electric Corp.	40	8-20	Under way	Britton Contr. Co.—Between Port Jervis and Poughkeepsie, N. Y.
Central Kentucky Natural Gas Co.	32	20	Planned	Loops from North Means, Ky., to northwesterly point in Nicholas County, Kentucky.
Chicago District Pipe Line Co.	41	24	Authorized	Loop Calumet Pipe Line.—Joliet, Ill., to Chicago, 12-50.
Cities Service Gas Co.	57	4 to 10	Under way	North Hugoton field, Grant and Stanton counties, Kansas, gathering lines.
City of Indianapolis, Inc.	55	16	Proposed	Indianapolis to Texas Eastern Transmission Corp. system.*
Coast Counties Gas & Electric Co.	40	3-4-8	Considered	Coast and Valley region, California.
Coastal Pipe Line Co.	1,000	..	Planned	Texas to Norfolk, Va.
Colorado Interstate Gas Co.	38	20	Authorized	Loops on western end of Lakin-Denver line in Colorado.
Colorado-Wyoming Gas Co.	30	10	Under way	Vaughn & Taylor Const.—Mesa to Boulder Junction, Colo.
Commonwealth Natural Gas Corp.	537	20	Proposed	West Bend, Ky., to Norfolk, Va.
Consolidated Edison Co. of New York, Inc.	23	30	Authorized	New York City to connection with Transcontinental system.
East Tennessee Gas Corp.	150	16	Under way	Knoxville to Bristol, Tenn.
East Tennessee Natural Gas Co.*	398	3-16	Proposed	Nashville-Chattanooga-Knoxville, Tenn., and laterals.
Eastern Natural Gas Corp.	292	24	Proposed	Phoenixville, Pa., via New Haven and Hartford, Conn.; Providence, R. I.; Springfield, Mass.; and Boston.
Egyptian Natural Gas Co.	80	6-8	Planned	Norris City to Salem-Centralia, Ill., area.
El Paso Natural Gas Co.	42	30	Under way	Company crews.—Deming Station to Valve 42, California line.
El Paso Natural Gas Co.	35	30	Under way	Company crews.—Pecos River to Keystone, Tex.
El Paso Natural Gas Co.	145	30	Under way	Company crews.—Wenden, Ariz., to Topock, Ariz., 8-50.
El Paso Natural Gas Co.	352	30	Under way	Company crews.—Looping of 26-in., New Mexico-California line and connection with Pacific Gas & Electric Co. at Needles, Calif., 11-50.
El Paso Natural Gas Co.	117	30	Under way	Company Crews.—California line to Topock, Ariz.
El Paso Natural Gas Co.	118	12	Under way	Company crews.—Goldsmith to Snyder, Tex.
El Paso Natural Gas Co.	31	30	Under way	Company crews.—Guadalupe Station to Valve 17 of California line.
El Paso Natural Gas Co.	68	30	Under way	Company crews.—Valve 56 to California line Valve 64.
El Paso Natural Gas Co.	450	24	Authorized	Company crews.—San Juan basin, New Mexico, to Franconia, Ariz., 11-51.

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"NOTHING ELSE can do the jobs a BAASH-ROSS SAFETY CLAMP will handle!"

IT PROTECTS . . . drill collars, flush pipe, tubing, etc., from dropping through the rotary table.

IT LIFTS . . . casing, liners, drill collars, pipe, tubing—even twist-offs—as temporary elevators.

IT SNUBS . . . drill pipe and tubing against upward movement when cementing, working under pressure, etc.

IT PULLS . . . pipe sections and similar cylindrical products horizontally for aligning, positioning, welding.

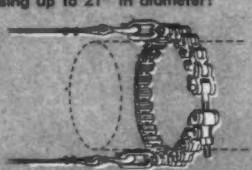
Regular Size Safety Clamp (Type CR), above, fits diameters 3¾" to 10⅝". Large Size (Type CL) fits diameters 11½" to 15½". Extra Large Size (Type CXL) fits diameters 15½" to 21". Tubing Size (Type T) fits diameters 1⅛" to 4½".

HERE THE SAFETY CLAMP (Regular size) is used to prevent drill collars and similar flush joint equipment from dropping through slips in the table. It is ideal for use with Baash-Ross Drill Collar Slips to give **double** protection against slipping!

WIDE ADADAPTABILITY

FOR LIFTING casing, pipe, liners or tubing, the Safety Clamp is equipped with lifting ears through which a sling can be fastened to substitute for elevators. The Extra Large Size shown here fits casing up to 21" in diameter!

FOR SNUBBING drill pipe and tubing, the Safety Clamp is simply inverted so the slip segments pull down instead of up. Easily-attached hold-down ears permit fastening anchoring cables with maximum speed and simplicity.



FOR PULLING pipe lines or pipe sections into alignment for welding, coupling or positioning, a Safety Clamp fastened around the pipe provides a slip-proof grip for pulling manually or mechanically.

Get Complete Details on the many ways Baash-Ross Safety Clamps can increase the safety and efficiency of your rig operations. Your local supply dealer will gladly supply full information —or write direct!

There seems to be no limit to the variety of jobs operators have figured out for the Baash-Ross Safety Clamp. Originally designed to take a quick, slip-proof grip on drill collars, liners and other flush joint equipment to prevent it from dropping through the table, it is now available in four sizes—Tubing, Regular, Large and Extra Large—to lift equipment *up* . . . or hold it *down* . . . or pull it *sideways. In fact, wherever you have a job calling for a firm grip on anything cylindrical—from only 1⅛" in diameter to 21"—the Baash-Ross Safety Clamp will probably do the job easier than you ever thought possible!*

HERE'S THE GRIPPING PRINCIPLE IN A NUTSHELL

The Safety Clamp consists essentially of many individual links flexibly hinged together. Each link has a tapered slip held in retracted position by a spring. When the Clamp is tightened around the pipe—a quick and simple operation—each slip takes a firm initial grip on the surface of the pipe. As the load increases, each slip is wedged tighter, preventing any slippage between pipe and Clamp. There's no risk of crushing thin-walled pipe or damaging pipe surfaces because the grip is *uniformly distributed around the full circumference.* And since each link is interchangeable as a unit, simply adding or removing links readily adapts the Clamp to virtually any diameter pipe in common use.

Baash-Ross Safety Clamps are available through leading oil field supply dealers.

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TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PIPE-LINE PROJECTS UNDER WAY AND PLANNED (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
Home Gas Co.	70	..	Planned	Orange, Sullivan-Rockland counties, New York-Cattaraugus County, New York, areas.
Jersey Central Power & Light Co.	39	10	Planned	New Jersey to coast system of Texas Eastern Transmission Co.'s Big Inch.
Kansas-Nebraska Natural Gas Co., Inc.	308	2-12	Planned	Loops, laterals, and replacements in Kansas and Nebraska.
Lone Star Gas Co.	67	6-8-10-12	Planned	Company crews.—Fort Worth to Wise Jack and Parker counties, Texas.
Lone Star Gas Co.	40	4-6-8	Planned	Company crews.—Bagwell, Tex., to Idabel and Broken Bow, Okla.
Lone Star Gas Co.	36	2-3-4-6-8-10	Planned	Company crews.—Garvin County, Oklahoma, to Katie field-gathering system.
Lone Star Gas Co.	46	3 to 8	Planned	Company crews.—Kerrville to Comfort, Boerne, Center Point, and Bandera, Tex.
Michigan Gas Storage Co.	150	20	Planned	Mahoney Contr. Co.—Chelsea terminal-Winterfield and Cranberry Lake, Mich.
Michigan-Wisconsin Pipe Line Co.	185	4 to 14	Under way	G. G. Griffis Const.—Laterals, Milwaukee to Fond du Lac, to Oshkosh, Appleton, Green Bay, Sheboygan, Manitowoc, and Two Rivers, Wis.
Michigan-Wisconsin Pipe Line Co.	42	14	Under way	G. G. Griffis Const.—Waukesha County to Sheboygan County, Wisconsin, laterals.
Michigan-Wisconsin Pipe Line Co.	51	8-10	Under way	G. G. Griffis Const.—Fond du Lac County to Winnebago County, and Sheboygan County, Wisconsin, laterals.
Montana-Dakota Utilities Co. and Montana-Wyoming Gas Pipe Line Co.	335	12	Under way	R. A. Conyes Const. Corp.—Worland, Wyo., to Baker, Mont.
Montana Power Co.	83	12	Under way	Deaton & Sons, Inc.—Bozeman to Butte, Mont., 7-1-50.
Northeastern Gas Transmission Co.	511	up to 20	Proposed	To extend from a connection with a proposed Tennessee Gas Transmission Co. extension to serve New England states.
Northern Natural Gas Co.	41	20	Under way	R. H. Fulton & Co.—Southwest from Garden City, Kans.
Northern Natural Gas Co.	46	4-12	Under way	R. H. Fulton & Co.—Garden City, Kans.
Northern Natural Gas Co.	71	20-24	Under way	Eastern Const. Co., Inc.—Looping in Kansas, Nebraska, and Iowa.
Northern Natural Gas Co.	111	24	Contracted	R. B. Potashnick—Ogden, Iowa, to St. Paul, Minn.
Northern Natural Gas Co.*	597	20-26	Contracted	Ten loops from Texas to northern Iowa.
Northern Natural Gas Co.	40	26	Contracted	R. H. Fulton & Co.—Loop 1, north of Skellytown, Tex., station, in Pampa station area.
Northern Natural Gas Co.	75	26	Under way	R. H. Fulton & Co.—Loop 2, north of Beaver, Okla.
Northern Natural Gas Co.	33	26	Contracter	R. H. Fulton & Co.—Loop 3, Mullinville, Kans., station.
Northern Natural Gas Co.	73	26	Contracted	R. H. Fulton & Co.—Loop 4, Bushton, Kans., station.
Northern Natural Gas Co.	155	20	Contracted	R. H. Fulton & Co.—Loop 5, Garden City to Bushton, Kans.
Northern Natural Gas Co.	43	26	Contracted	Midwestern Construction, Inc.—Palmyra, Neb., station, to Oakland, Iowa, station.
Northern Natural Gas Co.	65	26	Under way	Midwestern Construction, Inc.—Loop 7, northeastward from Oakland, Iowa, station.
Northern Natural Gas Co.	31	26	Under way	R. B. Potashnick Co.—Loop 8, north of Ogden, Iowa.
Northern Natural Gas Co.	41	26	Contracted	R. B. Potashnick Co.—Loop 9, northward from Ventura, Iowa, station.
Northern Natural Gas Co.	40	26	Contracted	R. B. Potashnick Co.—Loop 10, Ventura, Iowa, station.
Northwest Natural Gas Co.	750		Planned	Washington, Oregon, and Idaho.
Ohio Fuel Gas Co.	20	20	Under way	Somerville Const. Co.—Mount Gilead to Leesville, Ohio.
Pacific Gas & Electric Co.	47	8	Authorized	Salinas to Kilig City, Calif.
Pacific Gas & Electric Co.	426	34	Under way	Bechtel-Price-Conyes Corp.—Topock, Ariz., to Llanda, Calif.
Pacific Lighting Corp.	41	30	Planned	Puente to March field, Calif., 1950.
Panhandle Eastern Pipe Line Co.*	346	26	Authorized	Looping in Texas, Oklahoma, Kansas, Missouri, Illinois, Indiana, Ohio, Michigan.
Panhandle Eastern Pipe Line Co.	69	26	Under way	Midwestern Constructors, Inc.—Loop lines from Olpe to Hugoton, Kans.
Peoples Gas Light & Coke Co.	42	24	Authorized	Chicago city limits to Joliet, Ill., 12-50.
Phillips Petroleum Co.	45	2-24	.....	Vaughn & Taylor Const. Co.—Gathering system near Andrews, Tex.-Jess Moore.
Phillips Petroleum Co.	118	3-22	Under way	Vaughn & Taylor Const. Co.—Sherman and Hansford counties, Texas., gas-gathering system.
Piedmont Natural Gas Co.	1,350	30	Planned	Greenville, Miss., to Norfolk, Va.
Roanoke Pipe Line Co.	30	8	Authorized	Gala, Va., to Roanoke.
San Diego Gas & Electric Co.	53	16	Planned	San Diego County, California.
San Diego Gas & Electric Co.	85	..	Authorized	San Diego-Riverside-Moreno, Calif.
South Central Alabama Natural Gas Co., Inc.	150	..	Proposed	Central Alabama.
South Jersey Gas Co.	77	..	Planned	Camden to Atlantic City, N. J.
Southern California Gas Co.	83	30	Under way	Midwestern Constructors, Inc.—Whitewater, Riverside County, California, to Puente, Los Angeles County, California.
Southern Counties Gas Co. of Calif.	81	20	Authorized	Looping, 1950.
Southern Natural Gas Co.	32	16	Under way	Sheehan Pipe Line Const.—Elmore station to Mitchell Village, Ala.
Southern Natural Gas Co.	180	18	Under way	Sheehan Pipe Line Const. Co.—Gwinville, Miss., to Selma, Ala.
Southern Natural Gas Co.	110	11	Considered	Extension.
Southern Natural Gas Co.	118	13	Planned	Extension.
Southern Natural Gas Co.	138	20-22	Planned	Chattanooga, Tenn., to Lexington, Miss.
Southern Natural Gas Co.	171	16	Planned	Extension.
Southern Natural Gas Co.	225	16	Planned	Colfax, Ga., extension.
Southern Natural Gas Co.	314	18	Planned	Extension.
Southern Natural Gas Co.	375	24	Planned	Gwinville, Miss., to Atlanta.
Southern Union Gas Co.	78	8-10-14	Planned	New Mexico loops and laterals.
Tennessee Gas Transmission Co.	71	16-12	Under way	Latex Const. Co.—Kinder to Grand Chenier, La.
Tennessee Gas Transmission Co.	105	16	Contracted	Latex Const. Co.—Kinder, La., to East Bayou Sale, La.
Tennessee Gas Transmission Co.	91	30	Contracted	Okla. Contr. Corp.—Holly Springs, Miss., south.

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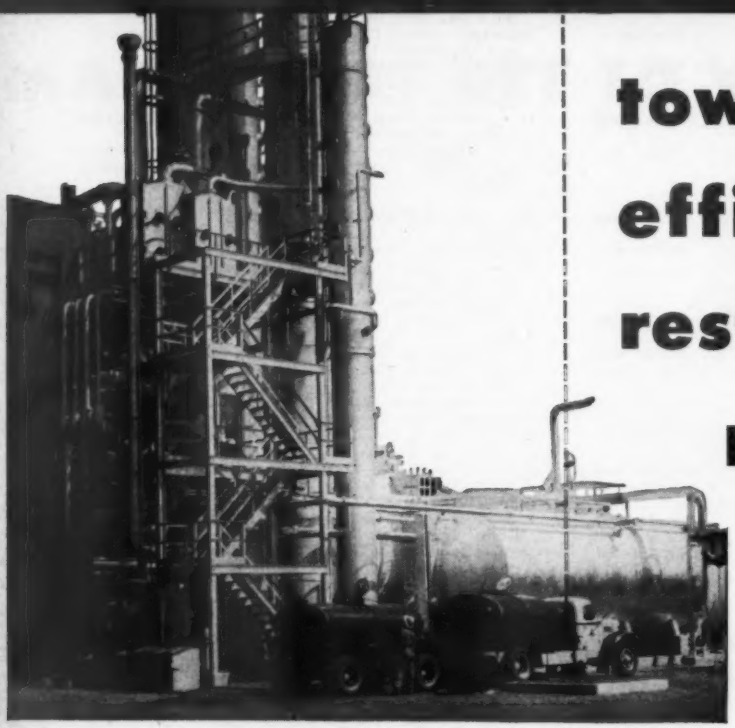

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TABLE 3—PRINCIPAL DOMESTIC NATURAL-GAS PIPE-LINE PROJECTS UNDER WAY AND PLANNED (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
Tennessee Gas Transmission Co.	103	26-30	Under way	Okla. Contr. Corp.—Premont to El Campo, Tex.
Tennessee Gas Transmission Co.	40	16	Under way	Beaver Falls and Pittsburgh, Pa.
Tennessee Gas Transmission Co.	63	26	Under way	H. C. Price Co.—South bank of Mahoning River near Youngstown, Ohio, and extending southwestward.
Tennessee Gas Transmission Co.	63	26	Under way	H. C. Price Co.—North bank of Muskingum River, and extending northeastward in Ohio.
Tennessee Gas Transmission Co.	47	26	Under way	H. C. Price Co.—South bank of Muskingum River, and extending southwestward in Ohio.
Tennessee Gas Transmission Co.	47	26	Under way	H. C. Price & Co.—North bank of Ohio River, and extending northeastward.
Tennessee Gas Transmission Co.*	790	20-26	Planned	Burnaugh, Ky., to Boston including 400-mi. line to Buffalo.
Tennessee Gas Transmission Co.	95	20	Under way	Latex Const. Co.—Natchitoches to Kinder, La.
Tennessee Gas Transmission Co.*	992	30	Planned	First 150 miles of loops to be laid at Monroe, La., Greenville, Miss., Midland and Portland, Tenn.
Tennessee Gas Transmission Co.	70	26-30	Contracted	Anderson Bros.—Between Stations 104 and 110.
Tennessee Gas Transmission Co.	170	26-30	Contracted	Kentucky.
Tennessee Gas Transmission Co.	90	30	Under way	Latex Const. Co.—West Monroe to Many, La.
Tennessee Gas Transmission Co.	33	30	Under way	Latex Const. Co.—Jones, La., to Mississippi River.
Tennessee Gas Transmission Co.	28	12	Under way	Massey Const.—Near El Campo to Traitor, Tex., 1950.
Tennessee Gas Transmission Co.	47	30	Under way	Morrison Const. Co.—Near Glasgow, northeastward to near Lebanon, Ky.
Tennessee Gas Transmission Co.	28	30	Under way	Morrison Const. Co.—Near Scottsville, southwestward to near White House, Tenn.
Tennessee Gas Transmission Co.	99	30	Under way	H. C. Price Co.—Near Dickson, southwestward to near Selmer, Tenn.
Texas Eastern Transmission Corp.	109	16	Under way	Smith Contr. Corp.—Baytown to Provident City, Tex.
Texas Eastern Transmission Corp.*	1,400	26	Planned	Texas to Pittsburgh loops.
Texas Gas Transmission Corp.	79	26	Under way	Williams Bros.—Branderburg, Ky., to Ohio River.
Texas Illinois Natural Gas Pipeline Co.	58	20	Authorized	Laterals, Joliet terminal to connection with Panhandle Eastern line near Volo, Ill.
Texas Illinois Natural Gas Pipeline Co.*	1,254	30	Authorized	Near Houston to vicinity of Joliet, Ill.
Transcontinental Gas Pipe Line Corp.	155	20	Contracted	R. H. Fulton.—Garden City to Bushton, Kans.
Transcontinental Gas Pipe Line Corp.	216	30	Under way	Midwestern Const., Inc.—Demopolis, Ala., to Newnan, Ga.
Transcontinental Gas Pipe Line Corp.* (main line)	1,840	30	Under way	Rio Grande Valley, Texas, to New York City.
Transcontinental Gas Pipe Line Corp.	85	4 to 14	Under way	Latex Const. Co.—South Louisiana.
Transcontinental Gas Pipe Line Corp.* (laterals)	502	..	Authorized	Unnumbered sections, Rio Grande Valley to Eunice, La.
Transcontinental Gas Pipe Line Corp.	108	30	Contracted	Williams Bros.—Section 6, Newnan to Danielsville, Ga.
Transcontinental Gas Pipe Line Corp.	86	30	Contracted	Williams Bros.—Section 7, Danielsville, Ga., to Saluda River, South Carolina.
Transcontinental Gas Pipe Line Corp.	102	30	Contracted	R. H. Fulton & Co.—Section 8, Saluda River, South Carolina, to Catawaba River, North Carolina.
Transcontinental Gas Pipe Line Corp.	100	30	Contracted	R. H. Fulton & Co.—Section 9, Catawba River, North Carolina, to North Carolina-Virginia boundary.
Transcontinental Gas Pipe Line Corp.	86	30	Contracted	O. R. Smith Contr. Corp.—Section 10, North Carolina-Virginia boundary to James River, Virginia.
Transcontinental Gas Pipe Line Corp.	110	30	Contracted	O. R. Smith Contr.—Section 11, James River, Virginia, to Potomac River, Virginia.
Transcontinental Gas Pipe Line Corp.	75	30	Contracted	Associated Pipe Line Contr.—Section 12, Potomac River to Susquehanna River, or Montgomery County, Maryland, to York County, Pennsylvania.
Transcontinental Gas Pipe Line Corp.	90	30	Contracted	Wunderlich & Griffis Const.—Section 13, Susquehanna, Pa., to Delaware River.
Transcontinental Gas Pipe Line Corp.	61	30	Contracted	Wunderlich & Griffis Const.—Section 14, Delaware River to Hackensack River, New Jersey.
Trunkline Gas Supply Co.	1,775	10-26	Contracted	Houston Contracting Co., Anderson Bros. Corp., R. H. Fulton & Co., Mahoney Contracting Co.—Includes 740-mile, 26-in., Lake Charles, La., to Tuscola station of Panhandle Eastern Pipe Line Co., and 1,035 miles, 10-24-in., Lake Charles, La., to McAllen, Tex., 10-1-52.
United Fuel Gas Co.	32	30	Authorized	Roane, Calhoun, and Wetzel counties, West Virginia.
United Gas Pipe Line Co.	42	20	Under way	O. C. Whitaker Co.—Ruston to Red River, La.
United Gas Pipe Line Co.	90	16	Planned	West Bay field to New Orleans.
United Gas Pipe Line Co.	51	12	Planned	Soso and Sherron fields, to near Meridian, Miss.
United Gas Pipe Line Co.	93	6 to 16	Planned	Fields in Plaquemines Parish to near New Orleans.
United Natural Gas Co.	60	12	Under way	Williams Bros.—Brookville, Pa.
Valley Gas Pipe Line Co., Inc.	1,500	24-30	Considered	Texas to Michigan.
Virginia Natural Gas Co.	153	..	Proposed	Buckingham to Richmond and Portsmouth, Va.

*Total mileage of project, details of which are given in items in this table.

TABLE 4—PRINCIPAL FOREIGN CRUDE-OIL PIPE-LINE PROJECTS UNDER WAY AND PLANNED

Cia. de Petroleo Ganso Azul, Ltd.	48	4	Planned	Ganso Azul field to Pucalipa on Upper Ucayali River, Peru.
Condor S.P.A. (Shell)	80	..	Planned	Genoa to Rho, near Milan, Italy.
Direccion General de Yacimientos Petroliferos Fiscales	25	..	Under way	Tupungato-Lujan de Cuyo, Argentina.
Direccion General de Yacimientos Petroliferos Fiscales	409	..	Under way	Plaza Huincul-Bahia Blanca, Argentina.
Estrada de Ferro Santos Jundiai	32	18-10	Under way	Santos to Sao Paulo.
Interprovincial Pipe Line Co.*	1,150	16-18-20	Under way	Edmonton, Alta., Canada, to Superior, Wis.
Interprovincial Pipe Line Co.	441	20	Under way	Canadian-Bechtel, Ltd.—Edmonton to Regina.
Interprovincial Pipe Line Co.	340	16	Contracted	Williams Bros.—Regina to Gretna, Man.
Interprovincial Pipe Line Co.	360	18	Contracted	Anderson Bros. Corp.—Minnesota and Wisconsin.
Iraq Petroleum Co.	556	30	Planned	Bechtel.—Kirkuk to Banias, Lebanon.
Basrah Petroleum Co.	72	12-16	Under way	Zubair to Fao, Iraq.
Middle East Pipelines, Ltd.	800	34-36	Planned	Iran-Levantine Port.

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TABLE 4—PRINCIPAL FOREIGN CRUDE-OIL PIPE-LINE PROJECTS UNDER WAY AND PLANNED (Continued)

Company—	Miles	Inch	Status	Contractor, location, and completion date
Montreal Pipe Line Co., Ltd.	68	18	Under way	Section 3, international boundary near Highwater, Que., to Montreal East.
Petroleos Mexicanos	160	11	Authorized	Minatitlan to Salina Cruz, Mexico.
Petroleos Mexicanos	145	13	Considered	Reynosa to Monterrey, Mexico.
Petroleos Mexicanos	280	13	Authorized	Poza Rica to Salamanca, Mexico.
Santos Jundiai Railroad	30	18	Planned	Santos to Sao Paulo, Brazil.
Trans-Arabian Pipe Line Co.	1,067	30-31	Under way	Abqaiq, Saudi Arabia, to Sidon, Lebanon.
Yacimientos Petroliferos Fiscales Bolivianos	327	6	Under way	Williams Bros. Co.—Camiri to Cochabamba.
Yacimientos Petroliferos Fiscales Bolivianos	44	4	Under way	Tapirani to Sucre.

*Total mileage of project, details of which are given in items in this table.

TABLE 5—PRINCIPAL FOREIGN PRODUCTS PIPE LINES UNDER WAY AND PLANNED

Cia. des Pipe Lines Petroliers Francais	150	10	Planned	Le Havre to Paris, France.
Colombian Ministry of Petroleum	90	6	Planned	Puerto Berrio-La Dorado, Colombia.
Colombian Ministry of Petroleum	103	4	Planned	Puerto Berrio-Medellin, Colombia.
Colombian Ministry of Petroleum	75	4	Planned	Buena Ventura-Cali, Colombia.
Creole Petroleum Corp.	10	8	Under way	Catia de la Mar to Nueva Caracas, Venezuela.
Northern Pipe Line, Ltd.	300	10	Planned	Montreal, Que., to Toronto, Ont.
Petroleos Mexicanos	160	11	Under way	Minatitlan to Salina Cruz, Mexico.
Santos Jundiai Railroad	40	10	Planned	Santos to Sao Paulo to Compinas, Brazil.
Svenska Enterprenad Atkiebolget	220	..	Planned	Uddevalla to Vasteras, Sweden.

TABLE 6—PRINCIPAL FOREIGN NATURAL-GAS PROJECTS UNDER WAY AND PLANNED

Azienda Generale Italiana Petroli	....	..	Under way	Lodi-Milan, Italy.
Azienda Generale Italiana Petroli	....	..	Under way	Lodi-Milan, Italy.
Azienda Generale Italiana Petroli	....	..	Under way	Lodi-Milan, Italy.
Direccion General del Gas del Estado	310	..	Planned	Plaza Huincul to Neuquen, Argentina, to the vicinity of General Conesa, Argentina.
Direccion General del Gas del Estado	62	..	Under way	Comodoro Rivadavia-Caleta Olivia, Argentina.
Northwest Natural Gas Co.	950	24	Planned	Alberta fields to Vancouver, B. C.; Seattle, Wash.; and Portland, Ore.
Petroleos Mexicanos	205	16	Considered	Monterrey to Torreon, Mexico.
Petroleos Mexicanos	260	20	Considered	Monterrey-Tampico-Poca Rica, Mexico.
Petroleos Mexicanos, Mexican Gas Co., and Industrial Gas Co.	600	..	Planned	Reynosa, Tamaulipas, to Mexico City.
Westcoast Transmission Co., Ltd.	1,406	30	Planned	North Alberta, Vancouver, B. C., and northern California.
Western Pipe Lines	710	22-24	Planned	Alberta fields, Saskatoon, Alta., to Winnipeg, Man., Canada.

TABLE 7—PRINCIPAL DOMESTIC CRUDE LINES COMPLETED

Company—	Miles	Inch	Contractor, location, and completion date
Brazos Oil and Gas	1	4	Continental Const. Co.—Submarine pipe line across Powderhorn Lake. 2-20-50.
Continental Pipe Line Co.	25	6	Goldenstern & Stolper, Inc.—Wichita Falls, Tex., southwest Block 110, Abs. 384 to Archer County, Texas.
Continental Pipe Line Co.	8	6	Goldenstern & Stolper, Inc., Block 17 in J. T. Belcher Subd., southeast Block 33 of H. Williams Sur., Abs. 704, Clay County, Tex.
Continental Pipe Line Co.	11	4-6-8	Mid-States Const. Co.—Christian County, Illinois.
Deep Rock Oil Corp.	3	3	Cushing, Okla.
Deep Rock Oil Corp.	12	2	Lease lines.
Derby Oil Co.	6	4	Knupp Const. Co.—Great Bend, Kans., to Valley Center pool.
Gulf Refining Co.	1	6	Latex Const. Co.—Near Grand Bayou, La.
Humble Pipe Line Co.	178	18	Morrison Const. Co.—Western section of West Texas-Satsuma Station, to Baytown, Texas, line.
Humble Pipe Line Co.	193	18	Anderson Bros. Corp.—Eastern section of West Texas-Satsuma Station, to Baytown, Texas, line.
Mid-Valley Pipe Line Co.	21	8	Latex Const. Co.—Section 8, Magnolia, Ark., to Haynesville, La.
Mid-Valley Pipe Line Co.	44	12	Latex Const. Co.—Delhi, La., to Mayersville, Miss.
Mid-Valley Pipe Line Co.	34	6-8	Latex Const.—Stephens to Magnolia, Ark., to Haynesville, La.
Magnolia Pipe Line Co.	25	8	C. L. Rogers Const.—Scurry to Iatan, Tex.
Magnolia Pipe Line Co.	13	8	C. L. Rogers Const.—Crossroads, N. M., to Gladiola Junction, Tex.
Magnolia Pipe Line Co.	23	8	C. L. Rogers Const.—Pegasus field to Midland, Tex.
Naph-Sol Refining Co.	9	4	Young Construction Co.—Big Rapids, Mich., to Woodsville.
Pacific Coast Pipe Line Div. (The Texas Co.)	23	8	Pacific Pipe Const.—Fillmore to Newhall, Calif.
Pasotex Pipe Line Co.	22	8	Carl H. Dunn—Kelley-Snyder field to Basin Pipe Line Co.'s Colorado City station.
Richfield Oil Corp.	20	14-16	(Somastic) Wheeler station to Newhall, Calif.
Service Pipe Line Co. (formerly Stanolind Pipe Line Co.)	31	10	C. S. Foreman Co.—Washington, Kans., to Freeman, Mo.
Service Pipe Line Co.	74	16	C. S. Foreman Co.—Washington, Kans., to Freeman, Mo.
Service Pipe Line Co.	62	12	Sheehan Pipe Line Const. Co.—LaPlata, Mo., to Wood River, Ill.
Service Pipe Line Co.	12	8	Bills & Troth Const.—Sussex to Salt Creek, Wyo.
Service Pipe Line Co.	10	6	I. C. Little Const.—Post Oak to Jacksboro Junction, Tex.
Service Pipe Line Co.	4	10	O. R. Burden Const. Co.—Maynard to Buckeye Pipe Line Co., Griffith station, Griffith, Ind.
Service Pipe Line Co.	33	8	Smith Contracting Corp.—Cogdell, Kent County, to Post, Garza County, Texas.
Service Pipe Line Co.	9	6	C. N. Deaton & Sons—North Cowden gasoline plant, Ector County, Texas, to Basin & Shell Pipe Line Co. line.
Service Pipe Line Co.	3	6-8	Salt Creek to Casper, Wyo., via Sinclair's 8-in.
Service Pipe Line Co.	3	6-8	Latex Const. Co.—Dawes Junction, Harris County, to Pan American's 12-in. near Jacinto City, Tex.
Shell Pipe Line Corp.	32	12	Smith Contracting Co.—Wasson, Tex., to Hobbs, N. M.
Shell Pipe Line Corp.	40	14	Latex—Hobbs to Jal, N. M.
Shell Pipe Line Corp.	160	10	Trojan Const.—Elk City to Cushing, Okla.

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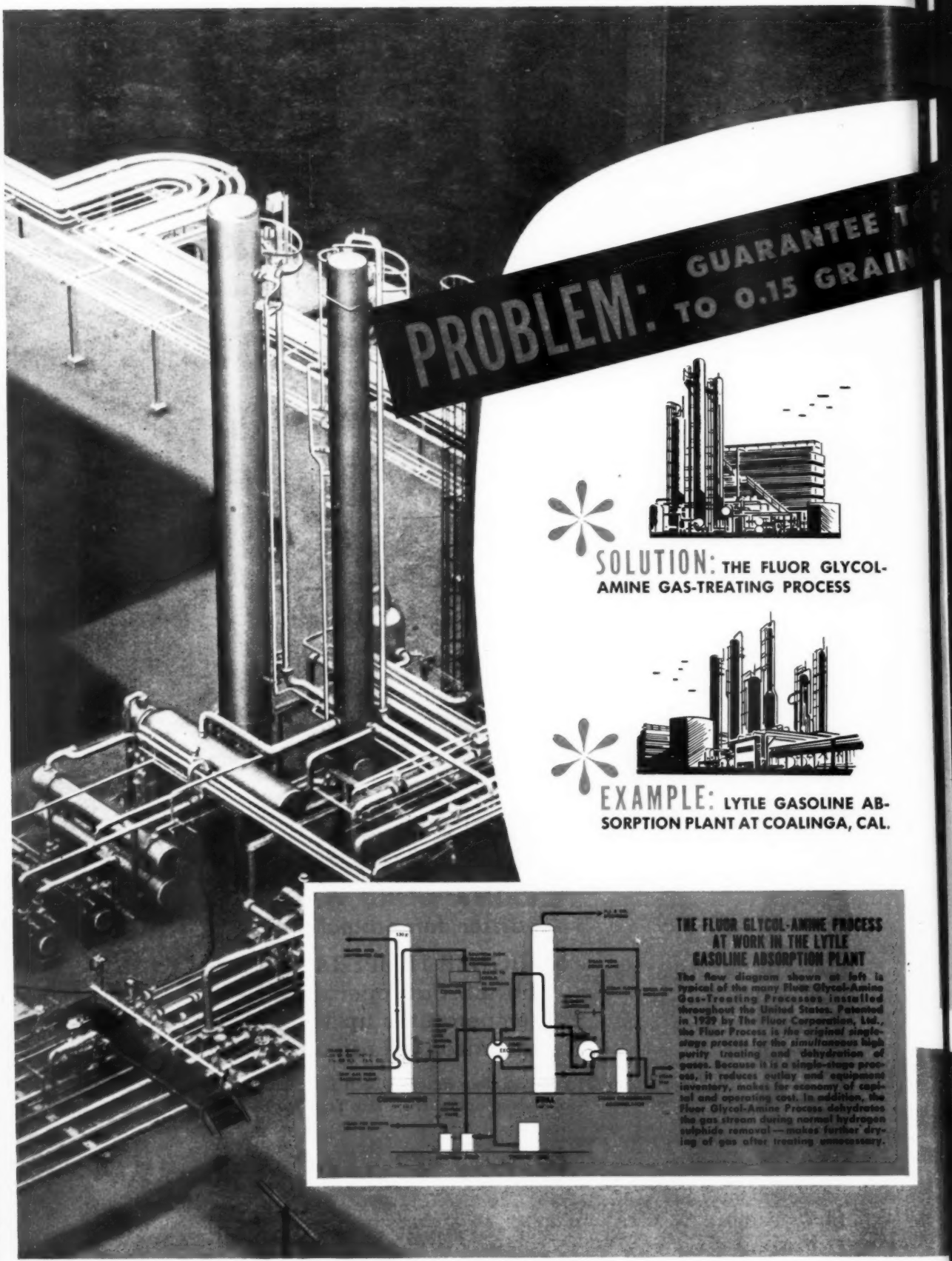

SOLUTION: THE FLUOR GLYCOL-AMINE GAS-TREATING PROCESS

EXAMPLE: LYTLE GASOLINE ABSORPTION PLANT AT COALINGA, CAL.

THE FLUOR GLYCOL-AMINE PROCESS AT WORK IN THE LYTLE GASOLINE ABSORPTION PLANT

The flow diagram shown at left is typical of the many Fluor Glycol-Amine Gas-Treating Processes installed throughout the United States. Patented in 1939 by The Fluor Corporation, Ltd., the Fluor Process is *the original single-stage process* for the *simultaneous* high purity treating and dehydration of gases. Because it is a single-stage process, it reduces outlay and equipment inventory, makes for economy of capital and operating cost. In addition, the Fluor Glycol-Amine Process dehydrates the gas stream during normal hydrogen sulphide removal—makes further drying of gas after treating unnecessary.

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The Lytle Gasoline Absorption Plant at Coalinga, California, is a story of the Fluor Glycol-Amine Gas-Treating Process at work.

Expansion of natural gas supply through deeper drilling introduced into the Lytle Plant a natural gas so high in hydrogen sulphide content that it was no longer acceptable as commercial sales gas. After processing for gasoline recovery, the discharge gas was analyzed and found to contain 1.25 grains of hydrogen sulphide per 100 SCF and up to three-fourths of 1 mol per cent of carbon dioxide. Even though this gas was sufficiently pure for sale in many areas, in this particular instance requirements for commercial gas were set to *not more than 0.15 grains of hydrogen sulphide per 100 SCF*... a purity requirement so stringent that it would only be attempted by Fluor Gas Processing Engineers using the Fluor Glycol-Amine Gas-Treating Process.

Following study of the requirement by Fluor, a Research Department pilot plant was set to run at gas composition and operating conditions simulating those at the Lytle Plant. Here it was *proved* the Fluor Glycol-Amine Gas-Treating Process could meet—*and exceed by a comfortable operating margin*—the 0.15 grain per 100 SCF requirement efficiently, economically, and on a guaranteed basis.

The plant for the Lytle job was then designed on the findings of the Fluor Research Department. Engineering was set in motion, and a field construction schedule formulated.

The Lytle unit is a "sweet"-running unit paralleling laboratory and pilot plant findings—meeting its guaranteed performance with an adequate margin. This new installation raises the total installed capacity of Fluor Glycol-Amine Gas-Treating Plants to 585,000,000 SCF/D.

Fluor invites owners and operators of gas-producing properties to submit their gas-treating problems for study and recommendation by Fluor's Gas Processing and Research Engineers. Let them study *your* particular problem—the range of purity obtained through use of the Fluor Glycol-Amine Gas-Treating Process is virtually unlimited. It may be the low-cost answer to your gas-treating problem.

Technical papers by Fluor research and engineering personnel are offered on the subject of gas treating—free copies are available by writing The Fluor Corporation, Ltd., Los Angeles 22, California.

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TABLE 7—PRINCIPAL DOMESTIC CRUDE LINES COMPLETED (Continued)

Company—	Miles	Inch	Contractor, location, and completion date
Shell Pipe Line Corp. and Texas Pipe Line Co.	435	22	Midwestern-Smith Contr.-Anderson Bros.—Cushing, Okla., to Wood River, Ill.
Skelly Oil Co.	32	8	Bishop & Lock—Burrton to El Dorado, Kans.
Texas-Empire Pipe Line Co.	43	16	O. R. Burden Const. Co.—Wilmington, Ill., to East Chicago, Ind.
Texas-New Mexico Pipe Line Co.	34	10	Carl H. Dunn—Colorado City to North Scurry and Kent counties, Texas.

TABLE 8—PRINCIPAL DOMESTIC PRODUCTS PIPE LINES COMPLETED

Great Lakes Pipe Line Co.	189	12	Kansas City to Des Moines.
Great Lakes Pipe Line Co.	64	12	O. R. Burden Const. Corp.—North from Des Moines.
Great Lakes Pipe Line Co.	54	12	A. C. Holder Const. Co.—Ponca City to Barnsdall, Okla.
Great Lakes Pipe Line Co.	224	12	Pacific Pipe Line and Engineers, Ltd.—Tulsa to Kansas City, Kans.
Great Lakes Pipe Line Co.	48	8	Trojan Const. Co.—Tulsa to Cushing, Okla.
Great Lakes Pipe Line Co.	20	12	Williams Bros.—Mississippi River crossing and line to terminal and station.
Pan-Am Southern Corp.	7	8	Schuler Relay to El Dorado, Ark., refinery.

TABLE 9—PRINCIPAL DOMESTIC NATURAL-GAS PIPE LINES COMPLETED

Alabama-Tennessee Natural Gas Co.	20	6	Decatur to Huntsville, Ala.
Arkansas-Louisiana Gas Co.	91	20	Latex Const.—Magnolia to Perla, Ark.
Bell Oil & Gas Co.	12	4	Healdton to Graham, Okla.
Cities Service Gas Co.	130	26	Sperling to Ottawa, Kans.
Cities Service Gas Co.	12	4-20	Gathering lines North Hugoton field in Grant and Stanton counties, Kansas.
Cities Service Gas Co.	35	26	Gathering line, North Hugoton field in Grant and Stevens counties, Kansas.
Cities Service Gas Co.	16	3-4	Kansas and Missouri.
Cities Service Gas Co.	29	16	Wichita to Hesston, Kans.
Cities Service Gas Co.	9	4-6-8	Gathering line, Guymon, Okla.
Cities Service Gas Co.	8	8-10	Gathering lines, Gray County, Texas.
Consolidated Gas Utilities Corp.	13	12	Elk City, Okla., gas field to main line at Carpenter, Okla.
El Paso Natural Gas Co.	26	30	Company crews—California line to Valve 31 of California line.
El Paso Natural Gas Co.	12	26	Company crews—California end of loop line.
El Paso Natural Gas Co.	22	30	Company crews—Pecos River to California line.
Lone Star Gas Co.	19	8	Bronte field to Miles, Tex.
Lone Star Gas Co.	8	3	Company crews—Van Zandt County, Canton, Tex.
Lone Star Gas Co.	19	6-8	Company crews—Breckenridge to Northwest Stephens County, Texas fields.
Lone Star Gas Co.	20	2-3-4	Company crews—Vicinity of Fort Worth to Justin, Roanoke, Tex.
Lone Star Gas Co.	17	6	Company crews—Hugo to Antlers, Okla.
Lone Star Gas Co.	8	3-12	Company crews—Anderson Co., to Cayuga field, Texas, gathering system.
Lone Star Gas Co.	11	6-8	Company crews—Northwest part of Wise County to Jack County, Texas, field.
Lone Star Gas Co.	13	4	Company crews—Limestone County, to Thornton and Kosse, Tex.
Lone Star Gas Co.	12	6	Company crews—College Station to Millican field, Texas.
Lone Star Gas Co.	20	8-10-12	Company crews—Alvrod, Snyder, and Scurry counties, Texas.
Lone Star Gas Co.	11	6-8	Northwest part of Wise County, to Jack County, Texas, field.
Lone Star Gas Co.	13	4	Company crews—6-in. line in Limestone County, Texas, to Thornton and Kosse, Tex.
Lone Star Gas Co.	12	6	Company crews—College Station to Millican field, Texas.
Lone Star Gas Co.	30	12	Company crews—Sweetwater to Snyder, Tex.
Lone Star Gas Co.	4	6	Company crews—6-in. line in Garvin County, Okla., to field northeast of Elmore City, Okla.
Michigan-Wisconsin Pipe Line Co.	26	6	G. G. Griffis Const.—Sheboygan County to Manitowoc County, Wisconsin, laterals.
Michigan-Wisconsin Pipe Line Co.	27	4	Rumsey Bros. Pipe Line Const.—Lateral line—Lee and Des Moines counties, Iowa, to Rock County, Wisconsin.
Michigan-Wisconsin Pipe Line Co.	12	4	Anderson Bros.—Rock County, Wisconsin.
Montana Power Co.	21	12	Deaton & Sons, Inc.—Vicinity of Billings, Mont.
Northern Natural Gas Co.	24	20-24	R. H. Fulton & Co.—Kansas.
Northern Natural Gas Co.	26	20	R. H. Fulton & Co.—Garden City, Kans.
Ohio Fuel Gas Co.	12	16	Somerville Const.—Amherst to Berlinville, Ohio. 7-10.
Plains Natural Gas Co.	78	4-12	Oklahoma-Kansas area, Hugoton field gathering system.
Pacific Lighting Corp.	23	30	Inglewood to Encino, Calif.
Phillips Petroleum Co.	25	..	Vaughn & Taylor Const. Co., Inc.—Gathering system-West Edmond, Okla.
Potomac Gas Co.	18	16	Dranesville to Arlington, Va.
Southern Natural Gas Co.	24	24	Sheehan Pipe Line Const. Co.—Loops to Mississippi, Alabama, and Georgia.
Tennessee Gas Transmission Co.	15	6	Latex Const. Co.—Near Tomball, Tex.
Tennessee Gas Transmission Co.	18	30	Anderson Bros.—Near Union City to Buckeye, Ky. 1950.
Tennessee Gas Transmission Co.	25	16	Latex—Kinder to Grand Chenier, La.
The Texas Co.	4	2-3	Continental Const.-Corpus Christi Bay—Submarine pipe line 2-27-50.
Texas Eastern Transmission Co.	10	10	Fowler Bros.—Fagus, Mo., to St. Francis, Ark.
Texas Eastern Transmission Co.	37	20	Associated Pipe Line Contr.—Station E, Bienville Parish to Sharon, La.-loop line.
Texas Gas Transmission Corp.	725	26	Lisbon, La., to Middletown, Ohio.
Texas Gas Transmission Corp.	43	20	N. A. Saigh and Fowler Bros.—Carthage to Red River field.
Transcontinental Gas Pipe Line Corp.	23	30	Oklahoma Contracting Co. — Unnumbered sections, Edgewater to Elizabeth, N. J.
United Gas Pipe Line Co.	105	20	O. C. Whitaker—Near Carthage, Tex., to near Sterlington, La.
United Gas Pipe Line Co.	26	20	Louisiana connecting with East Texas system.
United Gas Pipe Line Co.	25	16	J. Ray McDermott—St. Charles Parish to Orleans Parish, Louisiana.
United Natural Gas Co. (Pa.)	14	12	Connection to Tennessee Gas Transmission's Kentucky-Buffalo, N. Y., line.
United Gas Pipe Line Co.	23	16	Mud Lake field, Louisiana, to near Port Arthur, Tex.
United Natural Gas Co. (Pa.)	8	12	Eldred compressor station to Overbeck control station.
United Natural Gas Co. (Pa.)	11	12	Knox compressor station to Eldred compressor station.
United Natural Gas Co. (Pa.)	13	12	From Pew compressor station to Eldred station.
United Natural Gas Co. (Pa.)	9	4	Forest and Clarion counties, Pennsylvania.

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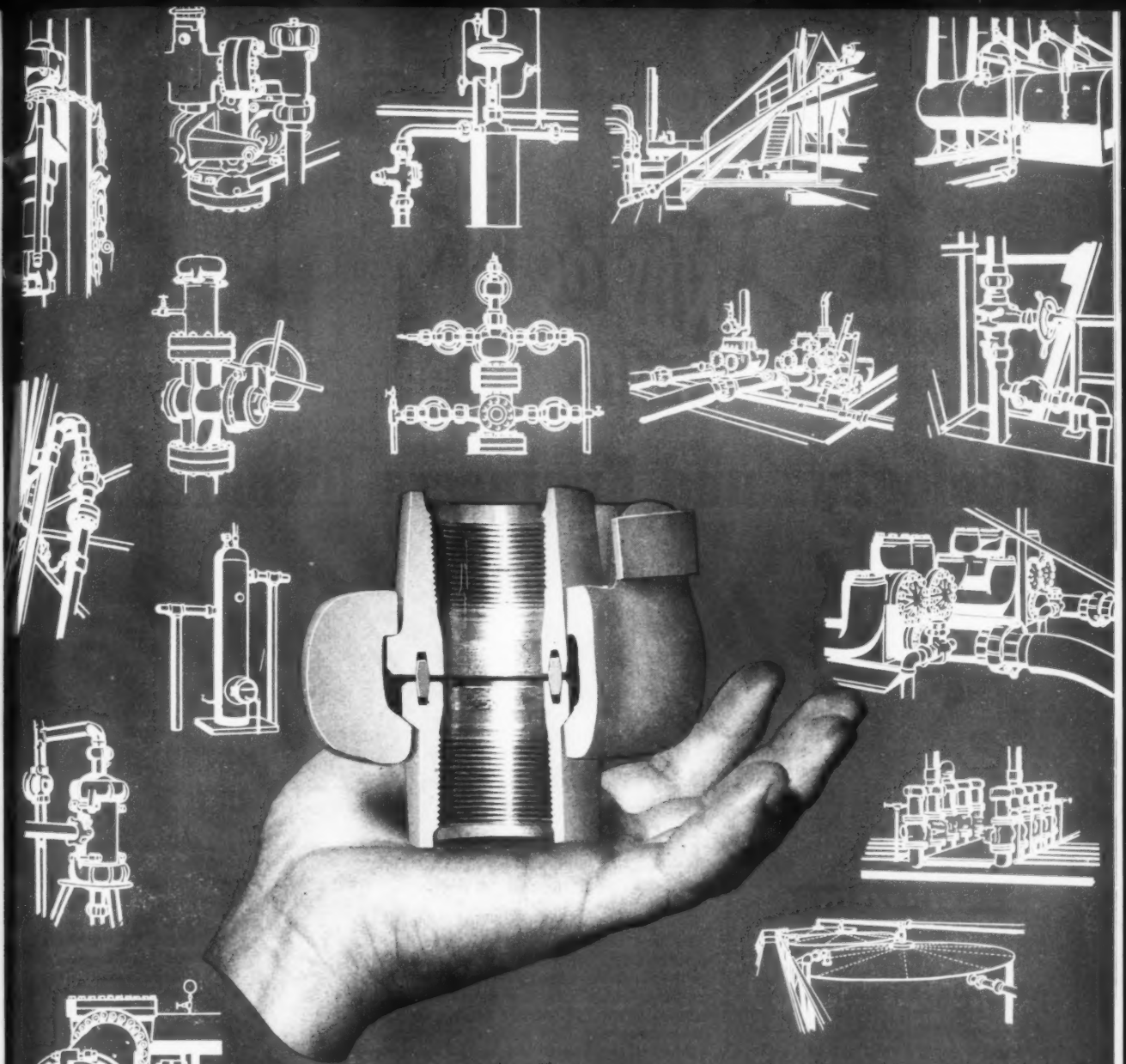

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Geologists and Engineers Disagree on Well Spacing?

by John G. Bartram

REFERENCE ENGINEERING SECTION

THE spacing of wells in oil pools is one of the major problems in the oil industry. What is the proper well spacing in each new field to recover the greatest proportion of the oil in the ground, and also to return a fair economic profit to the operator and royalty owner in a reasonable time?

The well-spacing problem has been studied both by geologists and by engineers, but it is far from settled, and there is still much disagreement. At the present time, many geologists tend to disagree with the engineers who, in the last 10 to 15 years, have greatly advanced their new science of reservoir engineering and have radically changed some of their older generally accepted ideas about the behavior of oil, gas, and water in reservoir rocks during the development and operation of oil pools.

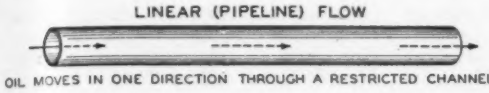
The geologists consider themselves qualified to decide questions on well spacing because the answers depend partly on the geological conditions of the reservoir rocks. Also, the geologists, as a group, started in the oil business first, and for some of the early years, the geologists did much of the oil-industry engineering. The first engineers worked mostly on equipment and mechanical problems, and the geologists still handled well spacing.

In the last 15 years, competent engineers have used their physical and mathematical methods to analyze oil-reservoir conditions and have learned that some of the earlier assumptions about reservoir mechanics were wrong. They have developed some entirely new concepts of reservoir behavior and oil-recovery methods. These reservoir engineers have convinced many of the other petroleum engineers, as well as most of the executives of the many oil companies for whom they work, and some geologists, that many of their new ideas are essentially correct, and that more oil can be recovered from oil fields if they are more scientifically developed and operated.

However, it appears now that, although geologists accept the engineers' conclusions about the benefits of controlled gas drive and water drive, many geologists are not convinced that the engineers are correct on the effect of close or wide well spacing on ultimate oil recoveries. Many geologists tend to believe that reasonably close well spacing is necessary for the most efficient recovery. Most engineers believe that (1) wider well spacing will suffice; (2) spacing

The Author

John G. Bartram, consulting geologist for Stanolind Oil & Gas Co., is a well-known geological authority, a former president of Tulsa Geological Society, and has been a frequent speaker before the A.A.P.G. Following his graduation from Williams College, Bartram spent 2 years in graduate study—one at Williams and one at Johns Hopkins University. He entered the petroleum industry in 1916 as a geologist for Roxana Petroleum Corp. and worked in Oklahoma, Kansas, Wyoming, and other states until 1923. In 1923 he became associated with Midwest Refining Co. When Midwest merged with Stanolind in 1932, he was named division geologist of the company's Rocky Mountain division with headquarters in Casper, Wyo. In 1939 Bartram transferred with Stanolind to Tulsa, as division geologist for the northern Mid-Continent area. He was named assistant manager of the exploration department in February 1944, and from January 1947 until January 1950, he served as manager of the exploration department.



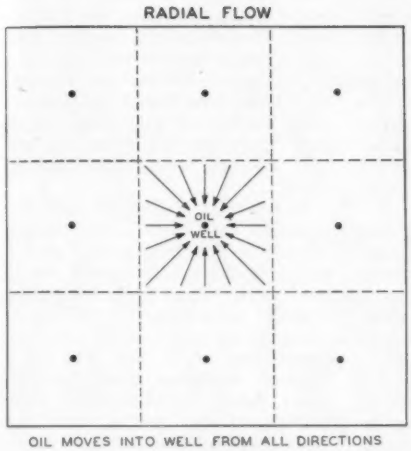


Fig. 1

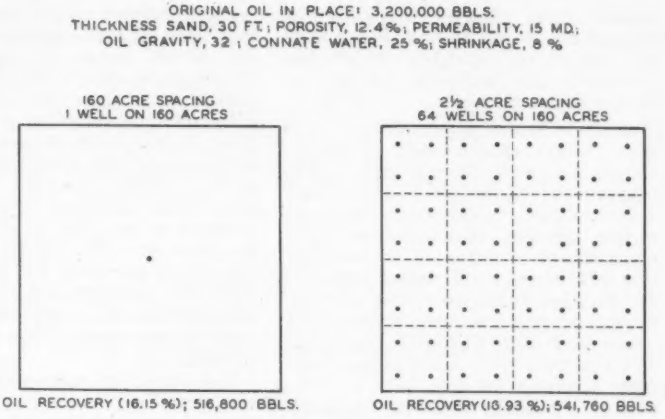

ORIGINAL OIL IN PLACE: 3,200,000 BBLS.
THICKNESS SAND, 30 FT.; POROSITY, 12.4%; PERMEABILITY, 15 MD.;
OIL GRAVITY, 32 ; CONNATE WATER, 25 %; SHRINKAGE, 8 %
160 ACRE SPACING
1 WELL ON 160 ACRES
OIL RECOVERY (16.15 %); 516,800 BBLS.
2½ ACRE SPACING
64 WELLS ON 160 ACRES
OIL RECOVERY (16.93 %); 541,760 BBLS.

Fig. 2

has much less effect on recoveries than many geologists assume; (3) properly controlled use of available gas and water to displace the oil is by far the most important factor in increased recovery; and (4) the oil should be recovered in one program, rather than in a primary program followed by a secondary program.

This disagreement between many geologists and engineers within the oil industry is serious. The drilling of more wells than are necessary is an economic waste. In fields with many closely spaced wells, the daily allowable production is often kept excessively high to repay the operators' higher drilling and operating costs. The resultant higher field allowables can dissipate, or otherwise inefficiently use reservoir energy, and seriously interfere with the reservoir engineers' program for the best ultimate recovery of oil.

Purpose of Analysis

This paper is written to analyze the reasons for this disagreement among many in the two groups of scientists in the same industry who should be able to agree on the solution of such a scientific problem, and who should be working together more efficiently for the best methods of oil recovery. The disagreement is mostly on two points:

1. The amount of reservoir energy required to move oil horizontally through the pores of the reservoir rock.

2. The continuity of porosity and permeability in the reservoir rock.

On the subject of reservoir energy, many geologists still hold to the older industry and engineering theory that it takes a large proportion of the available reservoir energy to move the oil horizontally through the rock into the bottoms of the wells. Hence, if the distance between wells can be shortened, the available energy will force more barrels of oil into the wells. The reservoir engineers are convinced that they have thoroughly disproved this old theory about reservoir energy. They believe only a small part of the reservoir energy is used to move oil horizontally to wells, and that large amounts of oil are not left stranded in fields simply because the wells were too widely spaced. The engineers' newer ideas appear so obvious to them that they find it difficult to understand why many geologists are unwilling to agree.

On the other point of disagreement, the continuity of porosity and permeability in the reservoir rock, many geologists suspect that most reservoir rocks may not have such continuity, but may be disconnected by irregularities of bedding and structure and by variations of porosity and permeability. They tend to favor closer well spacing in order to be certain that all parts of the reservoir are tapped by wells.

Many engineers believe that production data and well behavior indicate that wells have been drilled on unnecessarily close spacing in many fields. Later wells in partially depleted fields generally have the same production rates, pressures, gas-oil ratios, and other indexes of reservoir performance as the older wells. That proves the permeable zones in the reservoir rocks are generally more continuous than the average geologist thought they would be. The engineers recommend that new pools be started on wide well spacings and that more closely spaced wells be drilled only after they have been shown to be necessary. The engineers believe that too many new fields are permanently burdened with close spacing at the very start of development, before data are available to determine the proper spacing.

Mechanics of Reservoir Energy

The reason for this difference of opinion on problems of reservoir energy is largely due to unwillingness to accept new theories until they have been completely proved. People are always slow to accept new ideas that conflict with their established ones. Early astronomers said the earth was round, but they were not believed. Early petroleum geologists said the anticlinal theory could find valuable new oil fields, but "practical" oil men did not at first believe them. Now reservoir engineers present new theories on energy and recovery methods, and many in the oil industry hesitate to believe them. Of course, all new theories should be argued and tested before they are accepted, and some of the reservoir engineers' conclusions may be wrong.

It is not suggested here that new theories must be accepted simply because they are new. However, the writer does believe that some of these new engineering theories have been reasonably well proved and accepted by those best informed on the subject. Human inertia to change is delaying their acceptance by some geologists and others in the oil industry.

To what extent have the engineers proved some of the old theories wrong and their newer alternate theories right, so that more of the oil industry should agree with them? When the reservoir engineers started their study of reservoir mechanics about 15 years ago, most people in the oil industry had well-established ideas about the behavior and movement of oil, gas, and water in an underground oil reservoir. The ideas then current were widely published in engineering textbooks and in many technical papers. They were generally accepted as

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proved facts. Much of the earlier theory about oil reservoir behavior was based on "Cutler's Rule" and "Jamin Action," subjects that had received much publicity.

Cutler's Rule appeared to prove that closely spaced wells produced calculably greater percentages of the original oil than did more widely spaced wells. Presentations on Jamin Action showed that it took much more energy to force oil from a narrow tube when the oil was mixed with gas bubbles than when the oil contained no gas bubbles. It gave the impression that whenever the pores of a reservoir rock had free-gas bubbles mixed with the oil, a great amount of energy must be necessary to move the oil. Textbooks and published articles showed cross-sections of producing fields with partly drained and even undrained areas between wells. Everybody was quite convinced that horizontal movement of oil to the bottoms of the wells required much energy, probably a large proportion of the available energy.

Engineers' Studies

With this background, the engineers who were interested in oil reservoir conditions started analyzing the subject and collecting data. They accumulated figures on the results of fields that produced under different operating conditions and with different spacings. The engineers concluded from these statistics that well spacing was not the most important factor in ultimate oil recovery, but others examined the same data and reached contradictory conclusions.

It is probable that statistical analyses may never settle the well-spacing problem to everybody's satisfaction. Unfortunately, conditions in oil fields are so variable that the effect of any one factor cannot often be determined. Also, it is impossible to produce a field on 40-acre spacing, then put the oil and gas back into the ground and produce it again on 10-acre spacing to learn which is the more efficient. When both wide and close well spacing are used in the same pool, migration of oil through the reservoir rock from wide-spaced to close-spaced areas confuses the results. When similar fields are produced with different spacings, there are always other factors sufficiently variable to make comparisons uncertain.

Even though these statistical analyses cannot settle the argument beyond any question, this type of information from many fields is steadily accumulating until the amount of it is gradually convincing more people in the oil industry that the reservoir engineers' new basic theories are right.

Muskat in his recent book on petroleum engineering discussed the many published statistical analyses of well spacing and concluded, "Regardless of the nature of the statistical treatment to which they may be subjected, it is clear that they do not give any evidence for a real variation of the ultimate recovery with well spacing. They do not prove that such a variant is actually nonexistent. But, if any accuracy whatever is attributed to the data as a whole, they do show that the resultant effect of other factors, such as oil viscosity, formation permeability, and completeness of the water-drive action may be considerably greater than that of well spacing."

The reservoir engineers have also considered reservoir problems using physics and mathematics, subjects that the geologist needs only to a slight extent in his own profession, and in which few geologists are proficient. By these methods, the reservoir engineers have demonstrated that many of the older concepts of reservoir conditions were wrong or have been erroneously applied. Competent engineers state that Cutler's Rule is wrong for two reasons: (1) its calculations were based on linear (pipe line) flow, when they should have been figured for radial flow (oil moving toward a well from all directions) (see Fig. 1), and (2) Cutler assumed that the available energy was all used to move oil horizontally into the wells. He ignored the fact that most of the energy is spent flowing or lifting oil vertically in the wells, and much is vented on top of the ground. Before oil can move out of the pore spaces of the reservoir rock, it must be displaced by gas or water. Correct calculations on reservoir energy must include the efficiency of this displacement, and all related factors, such as rate of flow, permeability, viscosity, etc.

Cutler figured that, with different well spacings, it took 100 per cent more energy to move oil horizontally into 40-acre-spaced wells, 1,320 ft. apart, than into 10-acre-spaced wells, 660 ft. apart. Miller and Higgins later calculated that instead of 100 per cent more energy, it only required 10 per cent more to move oil horizontally into 40-acre wells than into 10-acre ones.

Keller and Calloway recently emphasized that calculations on horizontal use of energy are only part of the entire picture and cannot be considered alone. They have calculated theoretical recoveries for different well spacings in pools with average permeabilities of 15 and 300 md. They figured depletion-type (gas-in-solution) fields without any water or gas-cap drive effects, and used a well-abandonment rate of 3 bbl. per day. They got the following results:

FOR AVERAGE PERMEABILITY 15 MD.

Well spacing acres per well	Per cent of original oil recovered
160	16.15
80	16.27
40	16.45
20	16.52
10	16.60
2½	16.93

FOR AVERAGE PERMEABILITY 300 MD.

40	19.87
20	20.01

These figures were presented at a recent meeting of petroleum engi-

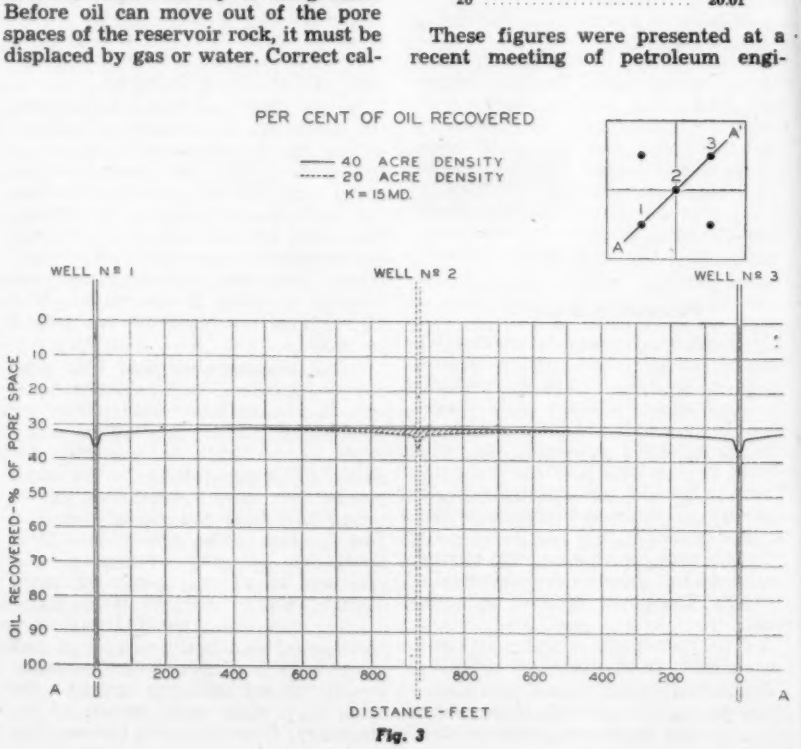


Fig. 3

JAMIN ACTION
GAS
OIL
GAS
OIL
GAS
IN A RESTRICTED TUBE, THE SURFACE TENSION ON GAS BUBBLES MIXED WITH OIL OR WATER REQUIRES GREATER ENERGY TO MOVE FLUID.

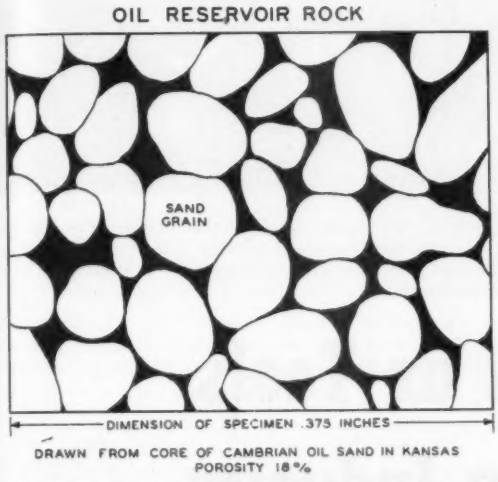
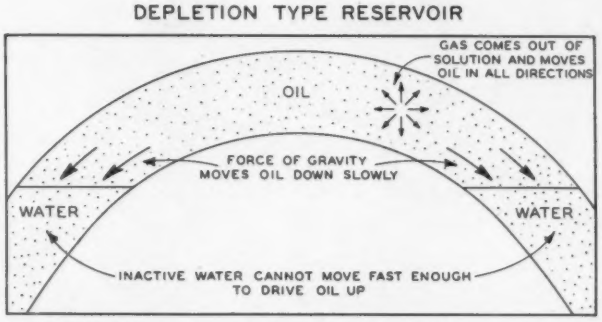

OIL RESERVOIR ROCK
SAND GRAIN
DIMENSION OF SPECIMEN .375 INCHES
DRAWN FROM CORE OF CAMBRIAN OIL SAND IN KANSAS
POROSITY 18 %
IN A PRODUCING RESERVOIR, THERE ARE FEW "RESTRICTED TUBES" IN WHICH JAMIN ACTION COULD BE EFFECTIVE, AND OIL, GAS, AND WATER CAN MOVE FREELY IN MANY DIRECTIONS.

Fig. 4


DEPLETION TYPE RESERVOIR
GAS COMES OUT OF SOLUTION AND MOVES OIL IN ALL DIRECTIONS
OIL
FORCE OF GRAVITY MOVES OIL DOWN SLOWLY
WATER
WATER
INACTIVE WATER CANNOT MOVE FAST ENOUGH TO DRIVE OIL UP
PRIMARY RECOVERY OF OIL MAY BE ONLY 15–25 % WHEN EXPANSION OF GAS-IN-SOLUTION AND GRAVITY ARE ONLY MEANS OF OIL DISPLACEMENT.

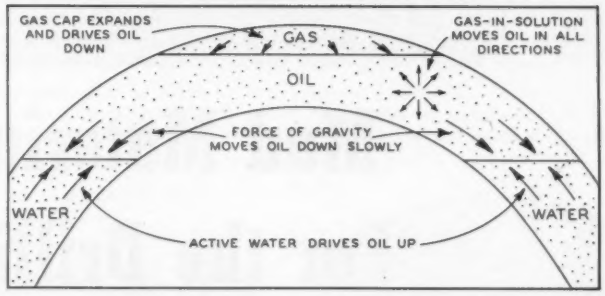

GAS CAP AND WATER DRIVE RESERVOIR
GAS CAP EXPANDS AND DRIVES OIL DOWN
GAS
GAS-IN-SOLUTION MOVES OIL IN ALL DIRECTIONS
OIL
FORCE OF GRAVITY MOVES OIL DOWN SLOWLY
WATER
WATER
ACTIVE WATER DRIVES OIL UP
PRIMARY RECOVERY OF OIL MAY BE 35 % WITH GAS CAP DRIVE AND 70 % WITH WATER DRIVE.

Fig. 5

neers, and apparently were regarded as essentially correct, since no engineer has disputed them. This theoretical calculation indicates that in two identical fields with all other factors equal, except the well spacing, one field with 2½-acre well spacing (64 wells on each 160 acres) will recover 16.93 per cent of the original oil in place, and the other field with 160-acre spacing (1 well on each 160 acres) will recover 16.15 per cent (see Fig. 2). The drilling of 64 times as many wells would recover only three-quarters of 1 per cent more of the original oil.

The small additional recovery for closer well spacing is calculated as due to slightly greater recovery in a very small area immediately adjacent to each well (see Fig. 3). The drilling of the additional well increases the oil recovery only by the amount shown by the diagonally shaded area. This is an extreme example, which will be accepted only by those who have studied the engineers' new theories and agree with them. It does show how radically different the new concepts of reservoir energy are from the older ones.

Regarding Jamin Action which appeared to prove that great amounts of energy were required to move oil in the reservoir rock, the engineers maintain now that it occurs in a restricted tube of certain configuration, but does not apply generally in reservoir rocks, particularly sands, where the pore openings are connected in all directions, and where the oil can move around freely (see Fig. 4). Many laboratory experiments on oil flow through reservoir rocks have proved that under oil-field conditions, Jamin Action has little or no effect. The engineers believe that, relative to the amount of energy available, very little energy is necessary to overcome friction or other interference to flow in ordinary oil reservoirs.

If the rock has any oil permeability, oil will move through it whenever there is any pressure differential. Permeability, of course, is the measure of the rock's ability to permit the flow of fluids. The rate of flow will depend on the amount of pressure differential, the permeability, and the viscosity of the oil.

Complete Recovery Program

The reservoir engineers have abandoned some of the older theories of reservoir behavior and replaced them with theories that fit basic physical principles. Using these, they plan complete recovery programs for fields to recover more of the original oil, at rates proper for current economic and market conditions, and at reasonable costs. Before a program can be chosen, many data should be developed on the extent and character of the oil pool and the fluids in it, and the kinds of energy available to move the oil into the wells must be known.

There are four sources of energy in a reservoir, and in any field, there may be any combination of the four (see Fig. 5):

1. Expansion of gas dissolved in the oil and liberated as the pressure declines, generally called "depletion-type" reservoir.

2. Expansion of free gas in either an original gas cap, or in a gas cap later formed during the production of a field.

3. Water drive, generally due to hydrostatic head in a water-bearing formation that is continuous to points of water intake, but in some restricted reservoirs may be due to actual expansion of the water in the reservoir as the pressure declines.

4. Gravity, which alone usually operates slowly under oil-field conditions, but supplements the effect of the other kinds of energy.

The recovery efficiencies of these different kinds of reservoir energy vary greatly. Water drive is much the best and engineers calculate that, when properly operated, it can push out and displace as much as 70 per cent of the original oil in many fields. Gas is less efficient than water in displacing oil, but the expansion of free gas in a gas cap, plus gas released from solution in the oil, can recover as much as 35 per cent of the original oil. In such fields, the energy of the expanding gas cap helps gravity

(Continued on page 325)

XUM

Left: Mud engineer and driller check mud properties on a Humble Oil & Refining Co. wildcat on the Gulf Coast. Center: Mud costs may be less than 1 per cent or as much as 60 per cent of the total cost of a well. This Humble roughneck is jetting a mud pit. Right: During 1949 the oil industry spent approximately 25 cents for each foot of hole drilled for mud materials. Derrickman T. C. Williams is testing mud viscosity on a Humble rig.

Mud Materials as Tools For the Drilling Industry

by Orien W. Van Dyke*

THERE is a definite trend in the oil industry today towards considering mud materials as tools. Instead of all-purpose additives, many of the mud materials currently in use are designed to serve a specific purpose. The proper use of these tools has taken much of the guesswork out of mud use, resulting in economies in drilling time and costs.

During 1949 the oil industry spent approximately 25 cents for each foot of hole drilled for mud materials. This is not an imposing figure, as it represents somewhat less than 3 per cent of the total cost of a completed well. Averages such as this, however, are not very helpful in estimating the cost of mud materials for a particular drilling operation. Mud costs might be less than 1 per cent or as much as 60 per cent of the total cost of a well. It is often said that 80 per cent of all mud materials used are consumed by only 20 per cent of the wells drilled.

Also, as drilling progresses to greater depths, the need for mud materials is increased many fold. As an example, in some areas in the Gulf Coast 8,000 ft. of hole may be drilled with less than $500 worth of mud materials, whereas a 14,000-ft hole in the same area may cost in excess of $30,000.

*Vice president, Magnet Cove Barium Corp., Houston.

REFERENCE ENGINEERING SECTION

Cost is only one of a number of reasons for drilling mud mushrooming from an insignificant role in rotary drilling to a status equal in importance to equipment. Many of the present drilling objectives could not be accomplished without careful drilling-fluid control. Casing programs, drilling rate, and completion results are factors which are directly influenced by drilling mud.

Developments in drilling mud have kept pace with the needs of the oil industry. In reviewing current practices it can be stated there are now available tools, in the form of mud materials and types of drilling mud, for satisfactorily handling every drill-

Aerial view of mining operation, Magnet Cove Barium Corp., in Arkansas.

Left: Marine locations in the Gulf Coast area complicate supply problems. Mud materials are being delivered to a Texas Co. water location with a war-surplus landing craft. The plane in the foreground is used by a mud-material company to fly trained technicians to marine locations. Right: Drilling-crew members unload mud materials on a lower deck of Humble's $1,200,000 Grand Isle, La., offshore platform.

ing problem that has been encountered to date. This does not mean that drilling-fluid control has reached a state of perfection. Quite to the contrary, the ultimate possibilities of the assistance the drilling operation can expect of drilling fluids is just beginning to unfold. Not all wells that are drilled use what is considered the best mud practice. This may be due in part to the lack of dissemination of drilling-mud information, lack of planning a complete mud program, or misinterpretation of the formation conditions encountered.

Drilling Mud Performance

It is reassuring to report that the behavior of drilling mud and the effect it has on the behavior of the hole while drilling are not as much of a mystery as they were a few years ago. A.P.I. Code 29, "Standard Field Procedure for Testing Drilling Fluids," (latest revision published May 1950), is a definite contribution to drilling, because it has standardized methods of measuring the physical and chemical properties of drilling mud. The properties of the mud can now be measured, and the results obtained correlated with the observed behavior of the hole. It is the accumulation of this experience information that has made progress possible.

Drilling-fluid control always presents two problems: (1) determining what is needed in the way of physical and chemical properties (weight, viscosity, gel strength, filtration, etc.) for a drilling mud to satisfactorily handle the drilling operation; and (2) the selection of mud materials, chemicals, and the type of mud that will result in a fluid with the desired measured properties.

There have been many cases of trouble encountered while drilling with a mud which was thought to be ideal as indicated by the measured properties. Such cases emphasize the importance of accumulated experience as to what measured mud properties are needed to accomplish a particular drilling operation. As an example, a mud having a weight of 11.5 lb. per gallon, viscosity 40 seconds, gel strength 0-5 g., and a filtration of 8.0 cc. might be perfectly suited for drilling in some areas, whereas it might be totally unsuited for drilling in an area requiring a mud with a weight of 9.6 lb. per gallon, viscosity 90 seconds, gel strength 10-30 g., and a filtration of 2.0 cc.; however, both of these muds could be considered as having good physical properties.

It was previously stated that there are tools available, in the form of materials for preparing mud, to handle every drilling problem which has been encountered. These tools are: **clays and bentonite** for viscosity, suspension and wall-building properties; **salt-water clays** that impart viscosity and suspending properties to saturated salt water; **barite weight materials** for preparing muds weighing in excess of 20 lb. per gallon; **pregelatinized starch and carboxymethylcellulose** for positive control of filtration characteristics regardless of contamination present; **materials for regaining circulation,** such as sized flake mica, cellophane flakes, organic fibers, cottonseed hulls, mineral and plastic sized aggregates; **chemicals for dispersing mud and treating out contamination:** quebracho and other organic dispersants, orthophosphates and complex phosphates,

This Humble-developed mud mixer requires only 10 hp. for its operation. Turbulence is generated by two propeller blades and vanes on the propeller shaft.

caustic soda, soda ash, sodium bicarbonate, and barium carbonate; **chemicals for preparing special types of mud**—lime, silicate of soda, salt, oil emulsion compounds, and **oil-base muds.** Limited use is made of proprietary compounds for such uses as breaking foam and preventing the decomposition of organic material.

The specific functions performed by drilling fluid can be summarized by pointing out the results that should be expected of drilling mud. It should allow the drilling of a bore hole to any desired depth through the various earth formations that will remain open, permit the taking of

(Continued on page 330)

XUM

Synthetic Plastics, Fibers, and Rubbers—From Petroleum

by Dr. E. V. Murphree

TODAY in the United States, petroleum and natural gas produce approximately 2 million tons of raw materials for synthetic organic chemicals yearly. The present high tonnages of petrochemicals require less than 1 per cent of the total petroleum production which, incidentally, is about 2 billion barrels of crude oil per year in the United States.

Up until about 10 years ago, coal, cellulose, water, air, and salt were the major raw materials employed in the synthesis of resins, fibers, and rubbers. In the past decade, however, petroleum has become a very important source of numerous organic raw materials which could not be obtained at least in sufficient quantity from other naturally occurring products or which had been produced from such natural products only at a somewhat higher cost.

The author is president, Standard Oil Development Co. The accompanying article is a summarization of a report presented at Semaine Technique de L' A. F. T. P. (L' Association Francaise des Techniciens du Petrole), Paris.

REFERENCE ENGINEERING SECTION

Availability of these raw materials derived from petroleum greatly stimulated the development and subsequent manufacture of many new polymeric materials. Synthetic rubbers, plastics, and fibers are all high-molecular-weight polymers formed by connecting a large number of certain building units, or monomers, into long chain or network molecules. Once the desired monomers are available at reasonable cost, the corresponding polymers may be produced by well-developed processes and at low enough production costs to permit widely diversified use of the products.

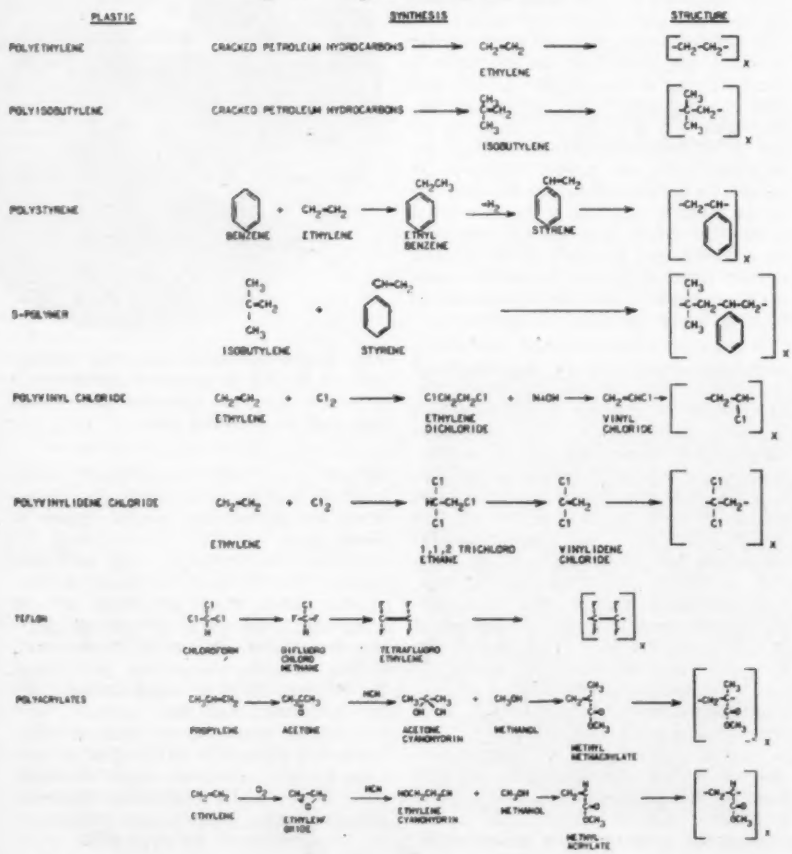
The petroleum industry generally speaking is, therefore, interested in rubbers, resins, plastics, ond fibers since, in addition to supplying solvents for such products, it is in a position to supply the raw materials such as ethylene, propylene, isobutylene, butadiene, cyclohexane, benzene, and xylene necessary for the manufacture of such high polymers and to develop and manufacture new and low-cost rubbers and plastics of an all-carbon nature.

Synthetic Plastics

It was not until World War I that the extensive development of plastics got under way and an industry of great importance was started. World War II opened up scores of new avenues for plastics use and availability of these plastics made some of our most important war efforts possible. Today, the extensive manufacturing facilities installed to produce these wartime plastics are turning out products for peacetime use, indicating the importance of resins and plastics as materials of construction. The only limitation on the use and application of plastics would appear to be the supply of raw materials and, in order to satisfy its present requirements, allow for expansion, and for the commercial development of new products, the plastics industry must be assured of a large and continuous supply of raw materials.

As will be seen from the discussion that follows, a great many of the organic chemical compounds necessary for plastics manufacture can be obtained directly or indirectly

Fig. 1—Synthetic Plastics



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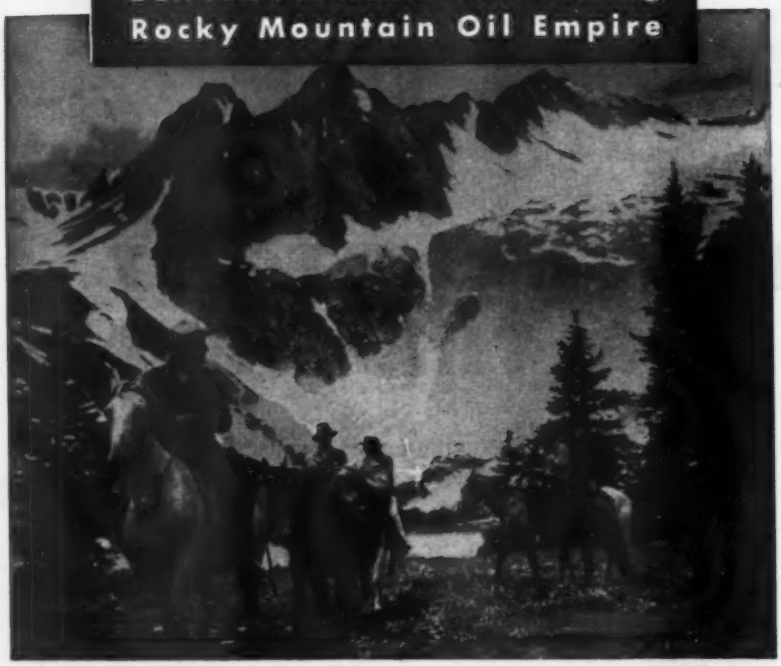

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from petroleum thereby providing the raw material source needed.

Polyethylene.—Cracking of various petroleum fractions results in the formation of ethylene which, in addition to its use in the synthesis of various chemicals, can also be polymerized at elevated temperatures and under high pressures in the presence of peroxide catalysts or oxygen to form an essentially saturated thermoplastic resin of the structure represented in Fig. 1. This resin is called polyethylene or polythene and is a new and very versatile plastic.

In reality polyethylene is a high-molecular-weight hydrocarbon (18,000 molecular weight) and consequently it possesses excellent dielectric properties, durability, flexibility, low water absorption, and low specific gravity which makes it a desirable material for use in high-frequency cables. In addition, because of its hydrocarbon nature, it is resistant to chemicals and weathering, it is tasteless, odorless, nontoxic, and possesses a low brittle point and a low moisture vapor permeability. The above properties make it useful in the manufacture of gaskets, packings, shower curtains, raincoats, ice-cube trays, tumblers, and packaging film for foods. It is also available in the form of a molding powder which can be converted into the many articles mentioned through injection, compression, and extrusion-molding operations.

Polyisobutylene. — Polyisobutylene is an elastic semirubbery solid produced from isobutylene by a low-temperature polymerization process similar to that employed in the manufacture of butyl rubber. In many respects it resembles polyethylene in that it is a high-molecular-weight paraffinic hydrocarbon of low unsaturation.

Variations in the polymerization conditions permit the production of polymers ranging from soft, sticky gums to tough, elastic solids and possessing molecular weights between 30,000 and 200,000. Because of its saturated structure it exhibits a high degree of chemical inertness, it is completely stable at atmospheric temperatures to oxygen and ozone, and improves the resistance of other elastomers with which it is blended. The polymers are also extremely resistant to the absorption of water and the diffusion of water vapor and many of its applications are based on this desirable property.

Polyisobutylene, in blends with paraffin wax, is used extensively in paper-coating applications. It also finds application in the formulation of adhesive compounds such as pressure-sensitive tapes and cements, in electrical insulation, chewing gum, as a plasticizer for polyethylene, and last but not least as a viscosity-index improver for motor oils.

Polystyrene.—Another high-molecular-weight all-hydrocarbon thermoplastic polymer of great industrial value is polystyrene, a resin produced by the polymerization of styrene in emulsion or in the presence of organic peroxides. Styrene is synthesized through the alkylation of benzene with ethylene followed by dehydrogenation of the resulting ethyl benzene.

Polystyrene is noted for its excellent electrical properties, low dielectric constant, and low power factor which result in its use in many high-frequency electrical applications, insulators, coils, condensers, and the like. It can also be molded

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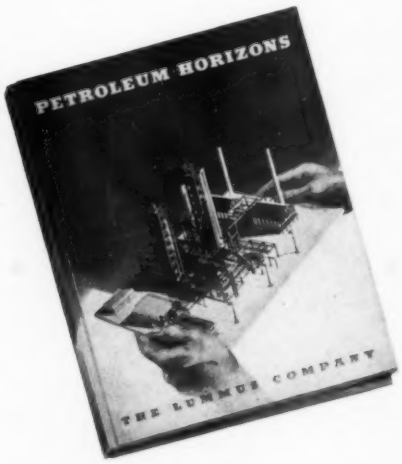

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to form numerous household and automotive parts as well as bottles, bottle caps, and battery boxes where its resistance to concentrated mineral acids can be used to advantage.

S-Polymer. — S-Polymer, a newcomer to the plastics field, is a copolymer of isobutylene and styrene prepared in a manner similar to butyl rubber and possessing properties substantially different from those of both polystyrene and polyisobutylene.

The most outstanding property of S-Polymer is its resistance to the penetration of moisture vapor. It has shown considerable promise as a packaging material for fruits, vegetables, cigarettes, and other hydroscopic substances. It can also be employed as a surface-coating material for paper, cloth, fiber glass, etc., or as an electrical insulating barrier, the latter application utilizing its good electrical properties.

Polyvinyl chloride and polyvinylidene.—Polyvinyl chloride and polyvinylidene chloride are two other plastics which have received extensive commercialization in the past few years. Vinyl chloride is prepared by the partial dehydrohalogenation of ethylene dichloride, the latter being obtained by the chlorination of ethylene. It can also be synthesized by the addition of hydrogen chloride to acetylene.

Vinylidene chloride is produced in a similar manner, namely by the chlorination of ethylene to 1,1,2-trichloroethane followed by dehydrohalogenation of the latter compound. The polymers are apparently manufactured by emulsion polymerization process in the presence of peroxide catalysts although mass and solution polymerizations have been employed.

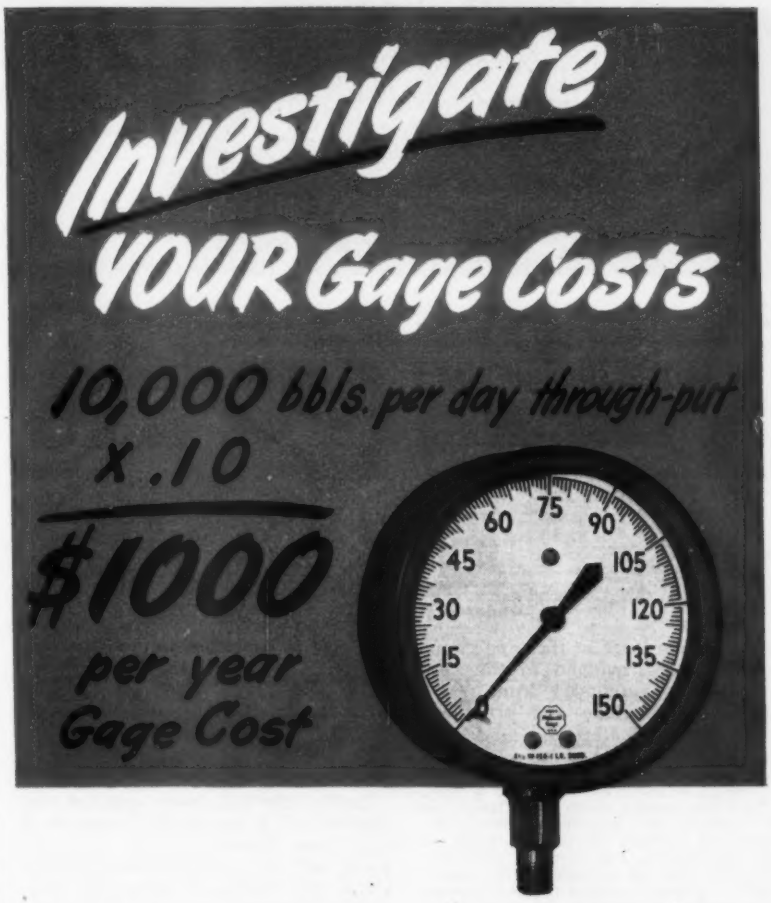
Polyvinyl chloride is a hard resin insoluble in most solvents. Although its tensile strength is decreased somewhat when plasticizers are added, this is normally done to improve the flexibility of polyvinyl chloride when it is used in the manufacture of food-packaging film, shower curtains, artificial leather, wire coating, tubing, and tank linings.

Polyvinylidene chloride possesses many of the properties of polyvinyl chloride and it can be extruded into monofilaments used in the fabrication of window screens or into tubes or pipes possessing unusual resistance to acids, bases, and salts including hydrochloric and nitric acids.

Teflon.—Teflon is a solid granular polymer made by polymerizing gaseous tetrafluorethylene. Because of its structure (indicated in Fig. 1) and the strong chemical bond between the carbon and fluorine atoms, Teflon is exceptionally resistant to chemicals and to heat.

It withstands the attack of practically all chemicals including chlorine and bromine and can be boiled in many solvents and mineral acids without a change in properties. In addition, it retains its toughness over a wide range of temperatures and possesses excellent electrical properties over a wide range of frequencies. At present, Teflon is being produced on a pilot-plant scale and it is used in the fabrication of gaskets, packing material, and electrical insulation.

Polyacrylates. — Polyacrylates are prepared by the peroxide catalyzed polymerization of the methyl esters of acrylic or methacrylic acids. Fig. 1



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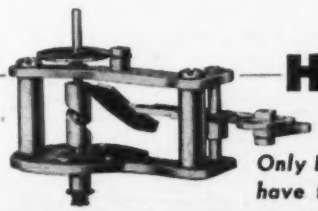

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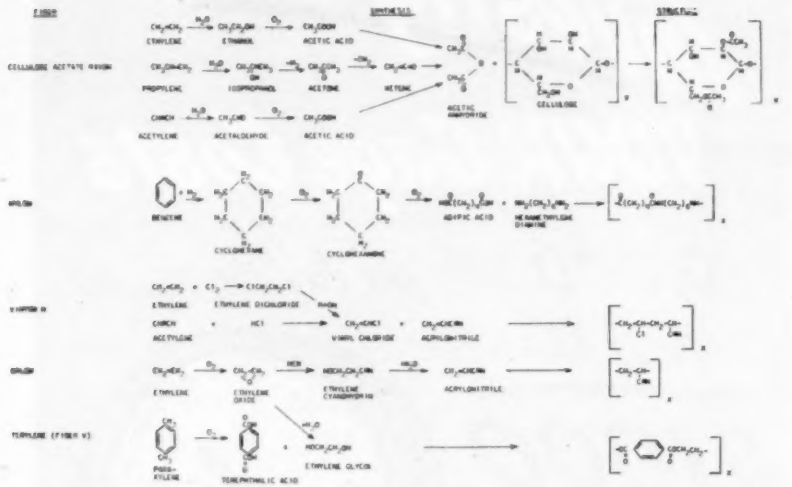
Fig. 2—Synthetic Fibers



shows the structure of these polymers and the steps involved in the synthesis of the monomers from petroleum using ethylene and propylene as the starting materials.

The major proportion of the polyacrylate production is in the form of cast sheets of polymethyl methacrylate which is a light, crystal-clear plastic, tough and flexible in thin sections, and capable of being machined and polished. Its clarity, excellent light transmission, and sunlight resistance allow this resin to be used in the manufacture of airplane windows, bomber noses, and decorative ornamental objects of many types.

Phenolics and alkyds.—Finally, there are two important types of resins, the phenolics and the alkyds, which can be produced from petroleum raw materials even though they are not being synthesized from such raw materials at the present time.

Cast phenolics have high tensile and flexural strength, good electrical insulating properties, and can be machined and polished. In addition they are extremely important ingredients in enamels, varnishes, and other protective coatings.

Alkyd resins are employed in a very large number of coatings from printing inks to coated fabrics. They are the most commonly used resins in outdoor paints and along with the phenolics and urea-formaldehyde resins, supply the major portion of the baking finishes and high-grade enamels and varnishes.

Synthetic Fibers

In the past petroleum was not considered as a commercial source of fiber raw materials since coal tar, wood, and other natural products supplied the necessary chemical compounds. Recently, however, as a result of the development of many new fibers and the expansion in the market for more established products, fiber raw materials from petroleum have achieved greater significance. The structures of five of the most promising synthetic fibers as well as the reactions involved in their preparation from petroleum hydrocarbons are shown in Fig. 2.

Cellulose acetate rayon.—Cellulose acetate is produced by the acetylation of cellulose, in the form of cotton linters or wood pulp, with acetic anhydride in the presence of acetic acid and a catalyst such as sulfuric acid. The acetic anhydride can be produced from petroleum in the three ways indicated in Fig. 2, namely: (a) hydration of ethylene to form ethyl alcohol which is subsequently oxidized to form acetic acid, (b) hydration of propylene to form isopropyl alcohol which can be dehydrogenated to acetone. The acetone is then pyrolyzed to produce ketene which, on reaction with acetic acid, results in the formation of acetic anhydride, (c) hydration of acetylene to acetaldehyde followed by oxidation of the latter to produce acetic acid.

After its formation and purification, cellulose acetate is dissolved in acetone, the resulting spinning solution is filtered, and then forced through the fine holes of a spinneret into a rising current of warm air which evaporates the acetone and leaves the cellulose acetate in the form of continuous filaments.

Acetate rayon possesses a degree of softness and resilience which gives fabrics a desirable drape, hang, and resistance to wrinkling and creasing. Like most natural and synthetic fibers, rayon finds its most important use in the manufacture of hoisery, and fabrics for women's clothing, household furniture, and the like. It is also employed in the preparation of tire fabrics although in this case the high-tenacity viscose rayon is usually required.

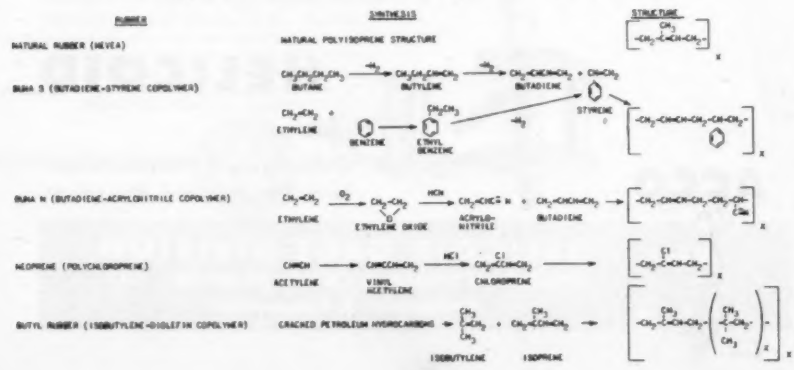
Nylon.—The first really true synthetic fiber to reach commercial production and the one which today is second only to rayon in its consumption, is nylon, a remarkable polyamide-type fiber introduced by the du Pont company in 1938.

The commonest textile form of nylon is made from two chemical compounds: hexamethylene diamine and adipic acid, both of which can be made from coal, air, and water or from cyclohexane, a petroleum product. As can be seen from Fig. 2, benzene can be hydrogenated to form cyclohexane or the latter can be isolated from straightrun naphthas. Oxidation of cyclohexane results in the formation of cyclohexanone which can be further oxidized to yield adipic acid. The adipic acid, in addition to being used as such, can also be converted to adiponitrile and finally to hexamethylene diamine.

The polyamide fiber formed in the manufacture of nylon possesses a strength equal to natural silk (65,000-117,000 psi.) and roughly equivalent to that of steel. In certain other properties it is superior to the natural fibers. Because of its many desirable and unique properties, this synthetic fiber is used not only in the manufacture of hoisery but also in such articles as parachutes, tents, glider tow cables, sails, tire cord, filter cloths, surgical sutures, bristles, and numerous articles of wearing apparel. Nylon is certainly a remarkable chemical development and it should achieve ever-increasing and widespread usage as its price decreases.

Vynyon N.—A new family of vinyl fibers, designated as Vinyon N, was announced in February 1947 by Carbide & Carbon Chemicals Corp. Vinyon N fiber is prepared from a vinyl chloride-acrylonitrile copolymer resin

Fig. 3—Natural and Synthetic Rubbers



MIOCENE SAND IN PARADIS FIELD ST. CHARLES PARISH, LOUISIANA

16

Mud (Caustic & Quebracho): R_m = 0.93 ohm at BHT
Bit Size: 9⅞″
Spacings: AM = 16″
AM′ = 64″
AO = 18′ 8″

LOG ANALYSIS

1) Water saturation S

R_o = 0.4 ohm from lower part of sand.
R_t = 25 ohms

$$S = \sqrt{\frac{0.4}{25}} = 12.7\%$$

2) Formation water resistivity R_w

$$SP = -90 \log_{10} \frac{R_m}{R_w} = -130 \text{ mv.}$$

$$R_w = \frac{0.93}{27} = 0.034 \text{ ohm at BHT}$$

3) Porosity p

$$F = \frac{R_o}{R_w} = \frac{0.4}{0.034} = 11.8$$

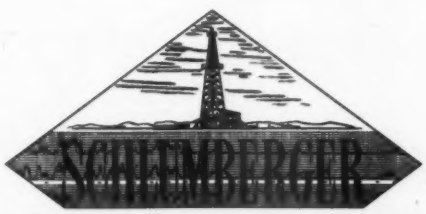
$$p = \sqrt[m]{\frac{1}{F}} = 25\% \text{ for } m = 1.8$$

CORE ANALYSIS

Average porosity from an adjacent well is 26.8%

PRODUCTION RESULTS

Perforated:	10,390 — 10,410
Production Potential:	208 BOPD 36° API
Gas/Oil Ratio:	482/1



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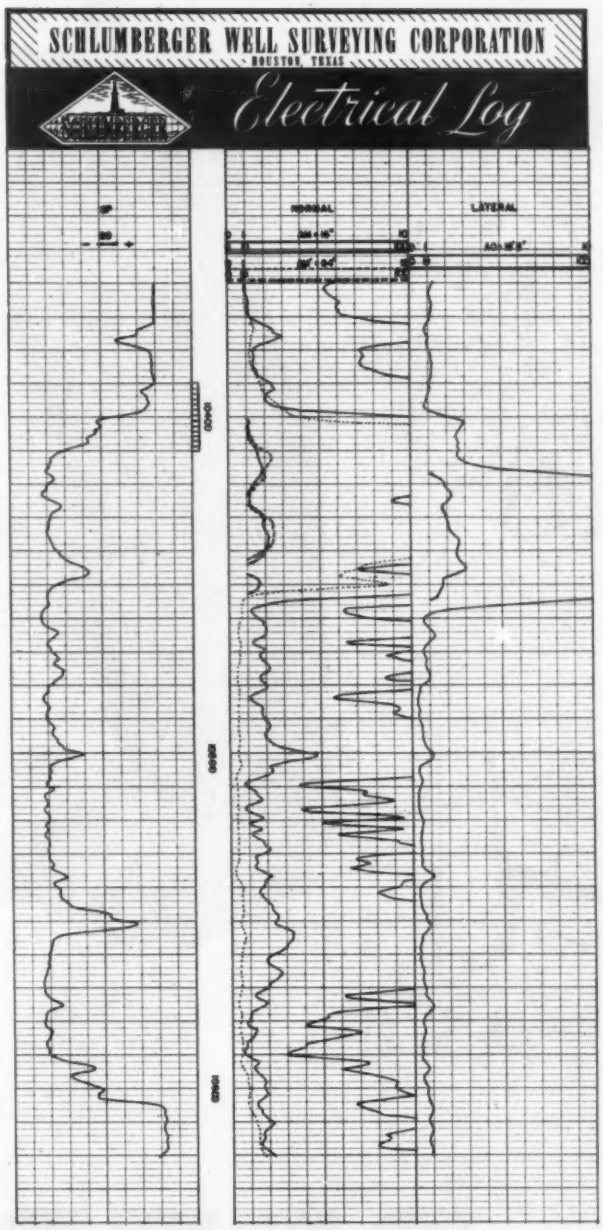

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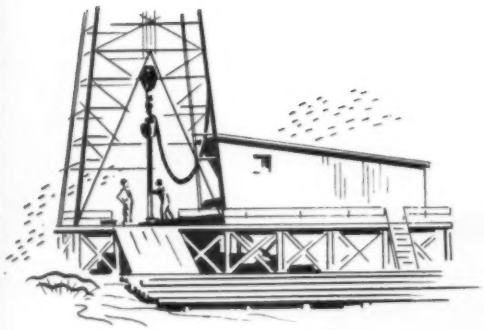

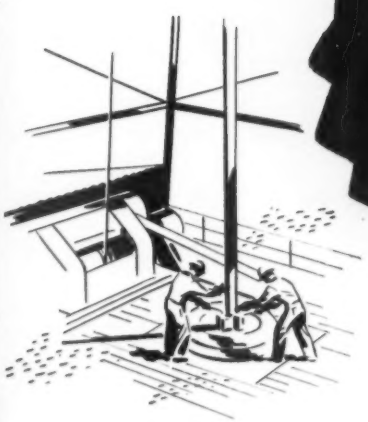

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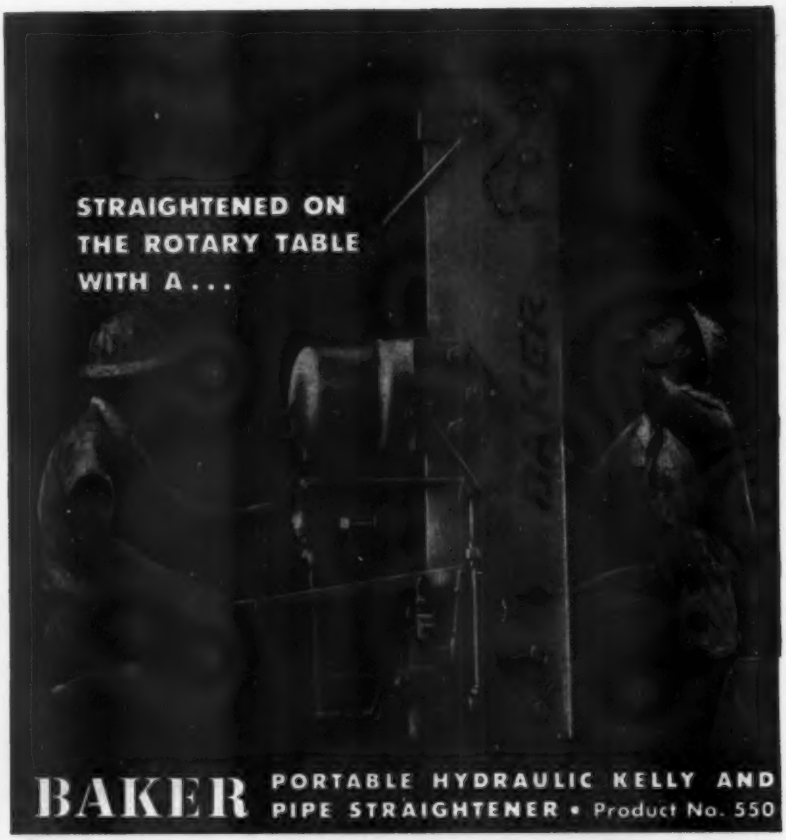

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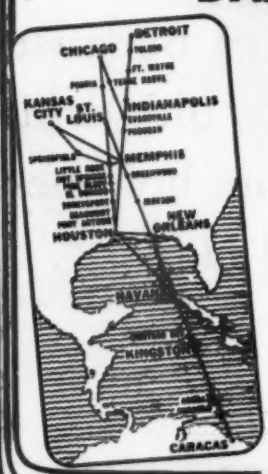

Chicago & Southern Air Lines' fleet of 4-motored Douglas Skymasters now offers seven-days-a-week service through the Houston and New Orleans gateways to Caracas, Kingston, and Havana. Flights each way every day provide one-plane service from the Great Lakes to the Venezuelan oil capital. Ask your travel agent or nearest C&S ticket office.

CHICAGO & SOUTHERN AIR LINES
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C★S

containing between 56 and 60 per cent vinyl chloride. The equations in Fig. 2 indicate the chemical reactions which occur in the synthesis of this monomer. Acrylonitrile is prepared from ethylene via ethylene oxide and ethylene cyanohydrin.

The vinyl chloride and acrylonitrile are copolymerized to form a resin using an emulsion polymerization process similar to that employed in the synthesis of the rubbers buna S, buna N, and neoprene. The conversion of the resin to a fiber or yarn is accomplished by either a dry or wet spinning process depending on the particular qualities derised in the finished product.

This interesting fiber has a high resistance to corrosive chemicals as well as to fungi, molds, and insects. It also possesses excellent water resistance, high electrical resistivity, and does not support combustion. Finally it has high tenacity with essentially no loss in the wet state, possesses high elastic recovery, is dimensionally stable in boiling water, and is readily dyed with cellulose acetate dyestuffs. Hosiery is a definite use for this fiber although other products such as filter fabric, electric insulation, protective clothing, awnings, upholstery fabrics, chemical-proof aprons, yacht sails, fire-resistant draperies, and the like can be made therefrom.

Orlon.—Orlon is one of the newest fibers synthesized by du Pont and, at present, it is in the development stage although commercial production is anticipated in 1950. This fiber is a high-strength yarn manufactured from polyacrylonitrile and having unusual properties which promise to open up new fields of use for textile fibers.

Orlon is produced by polymerizing acrylonitrile which, is one of the constituents of the oil-resistant rubber buna N and the fiber Vinyon N. Acrylonitrile is produced principally from ethylene via oxidation to ethylene oxide and the subsequent addition of hydrogen cyanide as indicated in Fig. 2.

Orlon is more resistant to sunlight and outdoor exposure than any other known fiber, it has extremely good resistance to degradation by heat and many chemicals, particularly mineral acids, and exhibits dimensional stability to dry and wet cleaning, low moisture absorption, rapid drying rate, as well as mildew and wrinkle resistance.

The properties suggest its use in acid-resistant clothing, automobile tops, outdoor furniture, window curtains, sails, rainwear, and many articles of wearing apparel.

Terylene and Fiber V.—Terylene (Imperial Chemical Industries) and Fiber V (du Pont) are very recent developments in the synthetic-fiber field and appear to offer numerous possibilities, although as yet they have not received extensive commercialization.

These two fibers are high-molecular weight polyesters produced by the interesterification of terephthalic acid with ethylene glycol. It will be observed in Fig. 3 that terephthalic acid can be obtained by the oxidation of paraxylene, a product which can be isolated in high purity from petroleum fractions. Ethylene glycol on the other hand is produced from ethylene by way of ethylene chlorohydrin or by the hydration of ethylene oxide.

Synthetic Rubbers

In 1925 the price of plantation rubber went up to over a dollar per

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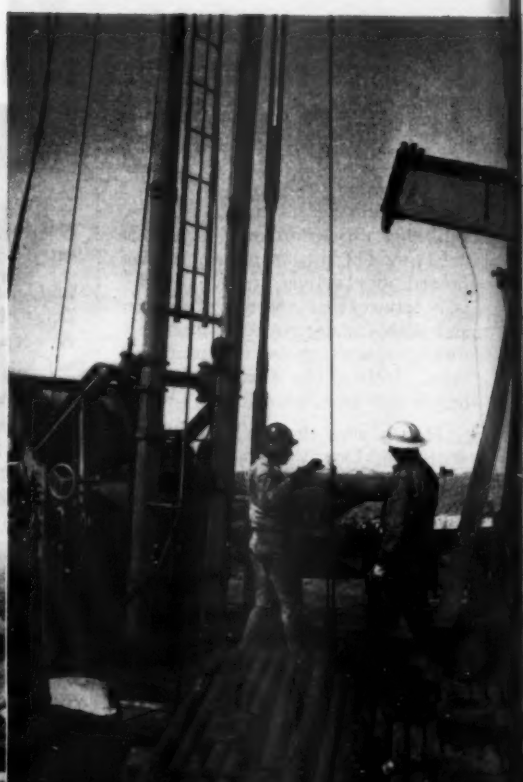
Pulling rods and tubing from a 4,000-fo Fast m well. Only two men are needed because hoist" the convenient ground location of contro table



"Mobilhoist" with jerkline spudder deepening a 3,300-foot well. Air controls operate the Cardwell Air Disc friction clutches in upper and lower drums.

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A "Mobilhoist" will "Buy Itself" because it's a real ALL-IN-ONE rig. One investment in one rig for all jobs. It eliminates the "stacked-rig" problem that eats away your profits in excessive fixed assets. You can use it on all kinds of drilling, workover, fishing and servicing jobs by simply changing standard attachments to do various kinds of well work.

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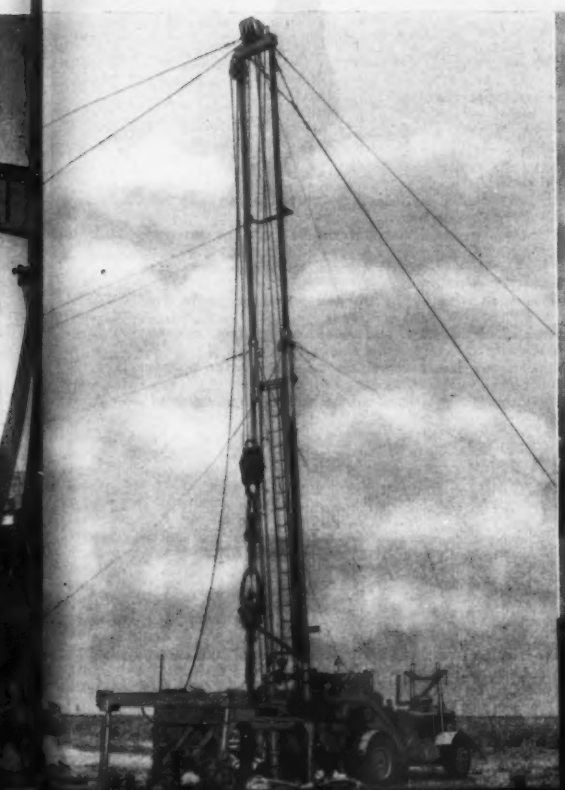
Fast moves and quick set-ups make the "Mobilhoist" ideal for reverse circulation jobs. Rotary table drive is interchangeable with spudder.

Using 2⅞" drill pipe, this double drum "Mobilhoist" with rotary table drive assembly is deepening a well on the Gulf Coast. Complete rig-up with 55-foot double leg mast was accomplished in less than two hours.



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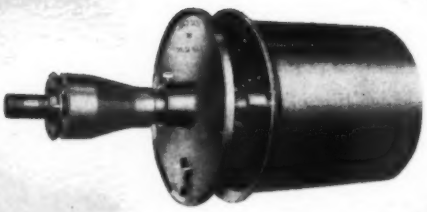

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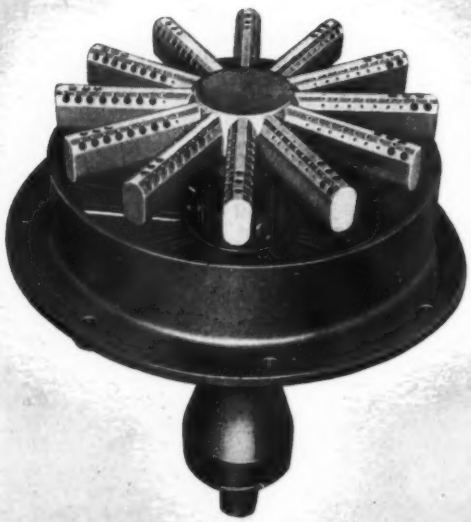

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Extreme simplicity of design and ease of control prevent operational difficulty.
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pound and this increase in price was a stimulus for renewed research on synthetic rubber all over the world. In 1925 and the years that followed, three major developments took place. The investigators centered their activity on the synthesis of other polymers and copolymers which would have the physical properties of natural rubber. This activity resulted in the appearance of buna S, buna N, neoprene, and butyl rubber. These synthetic rubbers while having some of the characteristics of natural rubber, also possess other properties which make them suitable for the production of articles for which natural rubber is not readily adapted.

The second development was the emulsion polymerization technique being used extensively at present in the manufacture of many of our high-polymeric materials such as buna S, buna N, neoprene, polyvinyl chloride, polyvinylidene chloride and certain other synthetic resins and rubbers.

The third development, which took place in 1937, involved the copolymerization of a mono olefin, specifically isobutylene, with a small amount of a conjugated diolefin at very low temperatures of the order of —100° C. using certain polyvalent metal halides as catalysts to form vulcanizable synthetic rubbers. This is the process used at the present time in the United States and Canada for the manufacture of butyl rubber and certain related high polymers.

Buna S.—Buna S, perhaps the most widely used synthetic rubber, is a copolymer of approximately three parts of butadiene and one part of styrene. The butadiene is presently prepared by dehydrogenation of normal butane or the butenes, as shown by the equation in Fig. 3.

Styrene on the other hand is produced by the alkylation of benzene with ethylene to form ethyl benzene which is subsequently dehydrogenated. The butadiene and styrene are then copolymerized using the emulsion process mentioned above to produce a synthetic rubber closely resembling natural rubber in its appearance.

Bune S, or GR-S as it is called in the United States, is definitely superior to natural rubber in resistance to aging although it is very similar in the properties of tensile strength, resilience, abrasion resistance, and elasticity. The chief disadvantages of this synthetic rubber are its high heat generation, low tear resistance and greater difficulty of processing, although tremendous strides have been taken during the past few years in overcoming these deficiencies.

In reality, buna S is a general purpose synthetic rubber and consequently it finds application in the fabrication of many mechanical rubber products where natural rubber itself was employed in the past. During the recent war and even at the present time its major outlet is in the manufacture of tires for passenger automobiles where its performance characteristics are about equal to those of natural rubber and tires containing both buna S and natural rubber are superior to prewar tires.

Buna N.—Buna N, sometimes called nitrile rubber, is a copolymer of butadiene and acrylonitrile containing between 50-75 per cent butadiene and 25-50 per cent acrylonitrile. It is produced by an emulsion polymerization process closely resembling that employed in buna S manufacture.

Because of the presence of the polar cyano or nitrile group in the polymer molecule, buna N vulcanizates are definitely superior to vulcanizates of natural rubber, buna S, and even neoprene in their resistance to oils, gasoline, solvents, and certain chemical reagents. It is therefore a unique type of specialty synthetic rubber and finds application in the manufacture of rubber parts which come in contact with petroleum products and certain solvents.

Articles such as carburetor diaphragms, aircraft hose, gaskets, self-sealing fuel tanks, printing rolls, hose for transferring petroleum products, and shoe soles are presently being made from the nitrile rubbers.

Buna N possesses another important advantage over natural rubber, buna S, and neoprene. Again because of the presence of the polar nitrile group in the polymer, nitrile rubbers are chemically and physically compatible with a wide variety of resins and plastics. This compatibility with resins is opening up a new field of application for the buna N rubbers in the manufacture of such articles as raincoats, shower curtains, artificial leather, food packages, floor coverings, and various household utensils.

Neoprene.—Neoprene or polychloroprene is produced by polymerizing acetylene to form vinyl acetylene which is subsequently reacted with hydrogen chloride to yield monomeric chloroprene. This monomer is finally polymerized in an emulsion process to form polychloroprene. The reactions involved in the synthesis of the raw material and the structure of the polymer are given in Fig. 3.

Neoprene is another rubber which is unique in several respects. Unlike natural rubber and the other synthetics, neoprene does not require sulfur or accelerators to produce vulcanization. Instead, metal oxides such as zinc oxide or litharge are normally used for this purpose. Likewise, carbon black does not increase the strength of neoprene as it does for buna S and buna N but only its stiffness.

Neoprene is superior to natural rubber and the other emulsion copolymers in its resistance to sunlight, atmospheric oxygen, ozone, and free flame and consequently it is used in the manufacture of hose, tank linings, electrical insulation, industrial truck tires, gloves, gaskets, and the like, particularly if the finished article is to be exposed to weathering.

Butyl rubber.—Unsaturation is introduced into the isobutylene polymer molecule by copolymerizing isobutylene with a small amount of a diolefin such as butadiene or isoprene using a polyvalent metal halide as a catalyst at a temperature around —100° C. This copolymer, which possesses a molecular weight between 40,000 to 80,000 and contains only 1 to 2 per cent of the unsaturation present in natural rubber, is now widely known as butyl rubber. Both of the raw materials, isobutylene and isoprene, used in the synthesis of this copolymer, are prepared by the cracking of petroleum fractions as indicated in Fig. 3.

Because of its branched structure and low unsaturation, butyl rubber is far better than natural rubber for many applications, particularly in view of the fact that the diffusion of air through butyl is about one-tenth that through natural rubber and it has unusually good age and tear resistance as well.

The low gas permeability, high tear resistance, and good age resistance even after long usage suggested the use of butyl in inner tubes and the major portion of the annual butyl rubber production is presently being employed in the manufacture of such inner tubes for automobiles.

Basic Hydrocarbon Raw Materials

Crude petroleum and natural gas are essentially saturated hydrocarbon materials; therefore, the naturally occurring hydrocarbon components are relatively inactive chemically. Huge quantities of methane, ethane, propane, and butane are available from natural gas and petroleum field gases at low prices, but they must be first converted into more reactive forms by such operations as cracking, dehydrogenation, reforming, or oxidation in order to be used in the manufacture of chemicals.

In general, it is the lower-boiling reactive hydrocarbons, such as ethylene, propylene, and butylenes, which are most valuable as chemical raw materials. Higher boiling hydrocarbons usually occur in such complex mixtures of similar components that they cannot be separated efficiently and economically to the high degree of purity normally essential for their further use in chemical manufacturing. There are exceptions to this, of course, as in the case of the light aromatics or the separation of relatively pure cyclohexane and other naphthenic hydrocarbons from certain virgin naphthas by precise fractional distillation.

The trend in petroleum refining during the past 10 years or more has been to produce motor fuels of improved quality and at higher yields from crude petroleum. This has led to the use of more drastic types of cracking and to the development of new processes such as catalytic cracking and hydroforming. As a result, reactive hydrocarbons, particularly olefins and aromatics, have become increasingly available as byproducts from normal refinery operations.

A necessary prerequisite to the use of petroleum compounds for chemical manufacture has been the development of new and improved methods of separation of the products, since specific compounds of high purity are usually required for the manufacture of polymers or their intermediates. When dealing with mixtures containing H_2, C_1, or C_2, the separation becomes fairly expensive because of the high volatility of these materials.

Good separations may be obtained by the use of conventional fractional

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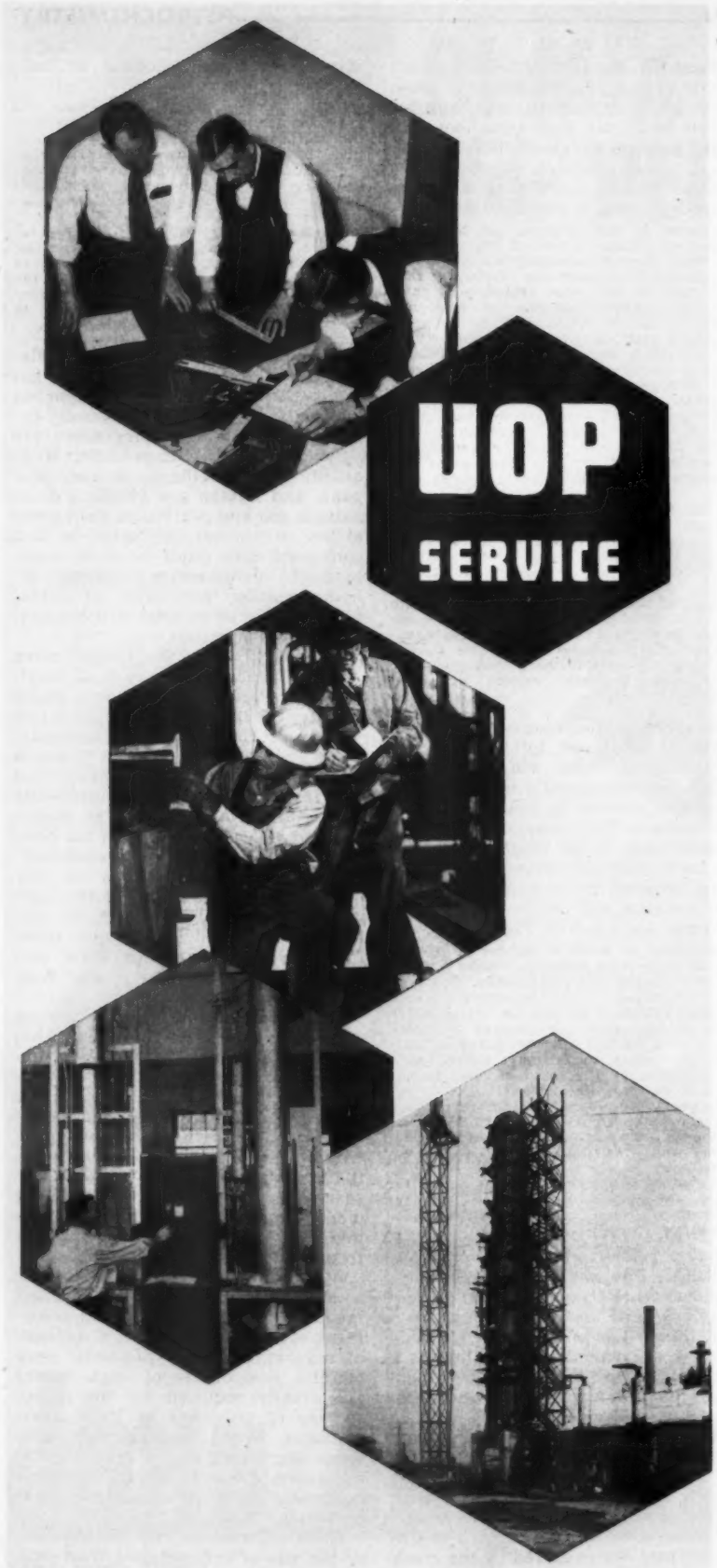

New Facilities Boost Ohio's Gasoline Yield

By Harry E. Handy
Superintendent
Robinson, Illinois, Refinery
The Ohio Oil Company

An increase of 7,000 barrels per day in the crude capacity of our principal refinery at Robinson, Illinois, has been effected with the completion of an extensive expansion and improvement program.

Harry E. Handy

Enlargement of our facilities was necessitated by the steadily growing demand for our products. In addition to processing more crude than formerly, the new facilities have enabled us to reduce former fuel oil yields by approximately one-third while substantially increasing the yield of gasoline and middle distillates.

Include Fluid Cat Cracker

The new facilities, process designed by Universal Oil Products Company, include a 27,500 b/sd two-stage crude distillation unit, a 12,400 b/sd UOP fluid catalytic cracking unit, a UOP catalytic-polymerization unit, a gas recovery system and a gasoline treating plant. Auxiliary facilities required as a result of the expansion of processing units included a water-circulating pump house, a cooling tower, a power house extension, 1,250,000 barrels of new tankage, an Ethyl blending plant and an A.P.I. oil separator.

The new processing equipment was installed as an integrated refinery area on a completely new site, thus allowing for economies in operating and maintenance which would not have been possible had the old equipment been combined in a revamp. Furthermore no costly shut down time was involved, as the old facilities could be operated up to the startup of the new plant.

The crude distillation unit includes facilities for atmospheric distillation, vacuum distillation and oxidizing or air blowing of asphalt. The crude oil passes through a desalter before entering the prefractionating column of the atmospheric unit.

Unit Simple in Design

The fluid catalytic cracking unit is of the latest design in which the regenerator is placed below the reactor and operates at approximately 15 psig. This made it possible to reduce the diameter of the regenerator 30% compared to a unit in which regeneration is carried out at approximately atmospheric pressure. It also resulted in elimination of the spent catalyst risers, which was one of the most troublesome lines in the wartime plants from the standpoint of maintenance.

(Advertisement)

The catalyst recovery system consists of three stages of cyclones on the regenerator, making unnecessary the installation of an electrical precipitator which was used on earlier units to recover catalyst fines. The reactor design includes dense phase horizontal grids in addition to the main distribution grid for reducing catalyst recycling in order to prevent excessive cracking and to insure maximum gasoline recovery. Internal and external strippers are provided for two-stage stripping of the spent catalyst. The reactor, external stripper and main fractionating column are lined with 11-13% chrome alloy to protect the equipment against the action of corrosive stocks.

Auxiliary Equipment

Auxiliary equipment for the cat cracker includes a pressured slurry settler, fired charge heater, flue gas steam generator and main fractionator steam generators, steam superheater for high pressure steam generated on the unit, gas engine driven gas compressors, and a condensing turbo blower silencer at the regenerator flue gas exhaust.

Prior to the completion of the new facilities we were operating the old crude unit (Crude Unit No. 1) at a crude rate of 18,000 b/sd on Illinois crude. The virgin gas oil was thermally cracked and the naphtha and heavy straight run grade was reformed in the Holmes-Manley cracking units in order to meet octane specifications. We were also operating a combination cracking coil with a crude capacity of 2,500 b/sd. This unit has facilities for crude distillation, visbreaking reduced crude and thermally cracking the gas oil fraction. The C_3-C_4 fractions from all these various cracking operations were processed in our old UOP catalytic polymerization plant for the production of polymer gasoline.

Crude Rate Up 7,000 b/sd

Since the installation of the new crude unit we have discontinued the operation of the old crude unit and also the combination cracking coil. The new unit (Crude Unit No. 2) handles all the crude we require, and is now operating at a crude rate of 28,000 b/sd, or approximately 7,000 barrels greater than was previously obtained by the operation of both the old crude unit and the combination unit.

The virgin gas oil from the crude unit is now charged to the fluid catalytic cracking unit and the mixed catalytic cycle stock is thermally cracked in the Holmes-Manley units. The naphtha reforming operation has been discontinued since the higher octane rating of the catalytically cracked gasoline for the present permits us to meet our octane specifications without the reforming operation and its accompanying reduction in gasoline yield.

The old UOP poly plant has also been discontinued since it is too small for the charge we now have and all the C_3-C_4 fractions from the cracking operations are processed in the new poly plant.

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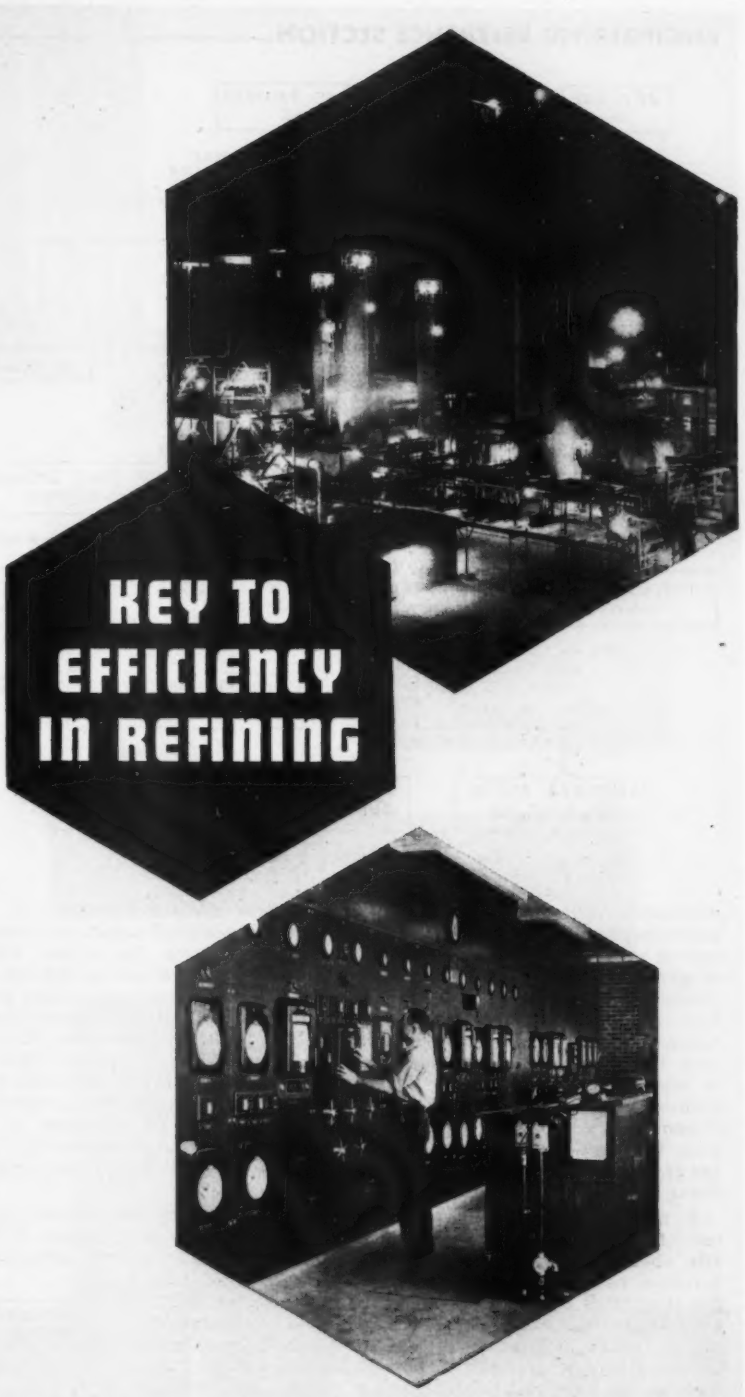

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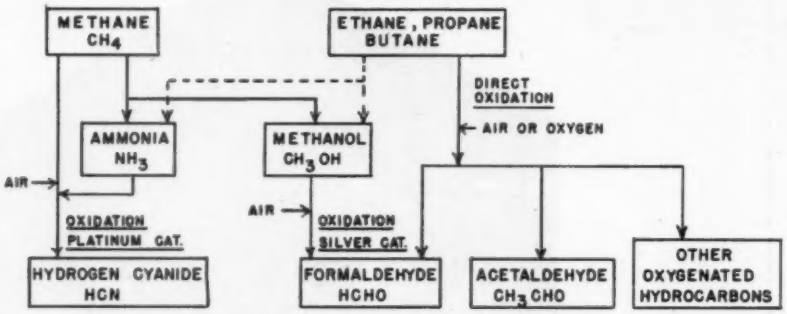


Fig. 4—Intermediates from light paraffins.

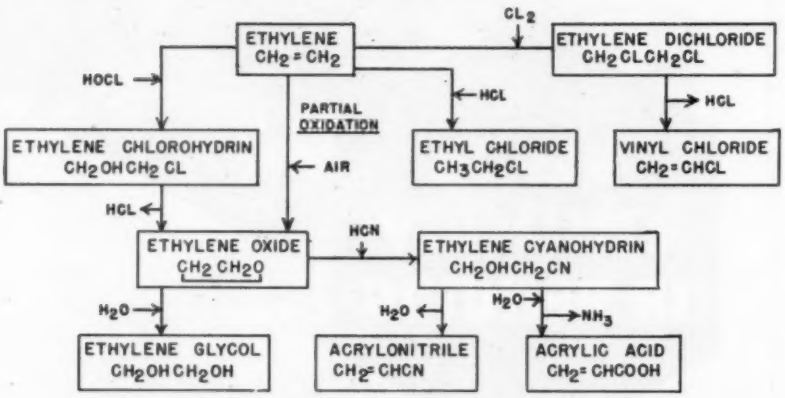


Fig. 5—Typical products from ethylene.

distillation, but high pressures and subatmospheric temperatures are required to avoid loss of C_3 in the hydrogen-methane stream. This requires considerable quantities of refrigeration and gas compression. Lower pressures and higher temperatures may be used if the first separation is made by absorbing all but the hydrogen and methane in a light-oil stream and then subsequently stripping the light oil within the same tower or in a separate tower to recover the C_3 and heavier compounds.

A new development involves the use of activated carbon to fractionally absorb the C_3 from the C_3. This involves relatively large equipment, but it reduces or eliminates the need for refrigeration and gas compression, and it results in good separation between components. Another possible method is fractional distillation at very low temperatures and normal pressures by the use of air liquefaction and distillation techniques.

Separation between hydrocarbons having the same carbon chain length is usually more difficult, requiring precise fractional distillation. In some cases, even precise fractional distillation may be impractical, as in the separation of butadiene from butene-1 in which case two new techniques may sometimes be used. By making use of the unique chemical reactivity of butadiene with cuprous salts to form addition compounds, butadiene is removed selectively and then recovered from the copper solution in a separate desorbing column. Certain selective solvents, when present during a distillation, increase the relative volatility between two other components and thus facilitate their separation. The removal of butene-1 from butadiene by distillation is made practical only by the presence of such a third component as furfural containing about 6 weight per cent water.

The lower aromatics, such as benzene, toluene, and xylenes, occur in crude petroleum in only limited quantities. The manufacture of toluene and xylenes from petroleum has become very important commercially, however, accounting for more than half of the total volume of these materials used in the United States. Their manufacture is accomplished by catalytic hydroforming, that is, reforming in the presence of hydrogen and a catalyst of selected, narrow-cut naphthas high in naphthenes. Thus, naphthenes such as methyl cyclohexane and dimethyl cyclohexane are dehydrogenated to toluene and xylenes, respectively. Highly aromatic hydrocarbon fractions may also be produced from naphthas and gas oils by drastic cracking operations such as the Catarole process. Very little benzene is as yet produced and recovered from petroleum in the United States for chemical use.

Little acetylene is produced from petroleum or natural gas in the United States, but light petroleum hydrocarbons may become an important source of acetylene in the future. The electric-arc process for converting methane to acetylene, as developed in Germany, may be of interest where cheap natural gas and electric power are available. Acetylene may also be produced by high-temperature regenerative cracking of ethane and propane in brick checkerwork furnaces, or by oxidative cracking of natural gas.

Intermediates used in the production of synthetic rubbers, plastics, and fibers.—Methane is available at a high level of purity and at low cost in the United States. The conversion of methane to methanol and to ammonia is well known and is practiced on a large scale commercially. As indicated in Fig. 4, hydrogen cyanide, essential for the production of acrylonitrile and the acrylates, is also produced from methane. Ammonia, methane, and air are reacted in a one-step process over platinum catalyst at a bright red heat to produce good yields of hydrogen cyanide.

Methanol is converted on a large scale to formaldehyde, a major ingredient of a large group of resins and plastics. This is done by oxidation of the methanol with air over a prepared silver catalyst at temperatures in the range of 600° C.

Other light paraffins, such as ethane, propane, and butanes, may be used in the manufacture of ammonia or methanol, or they may be oxidized directly under carefully con-

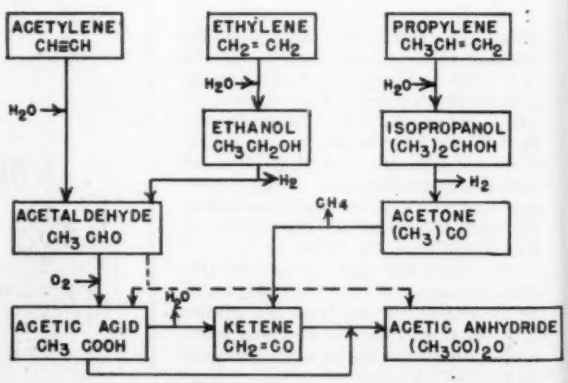
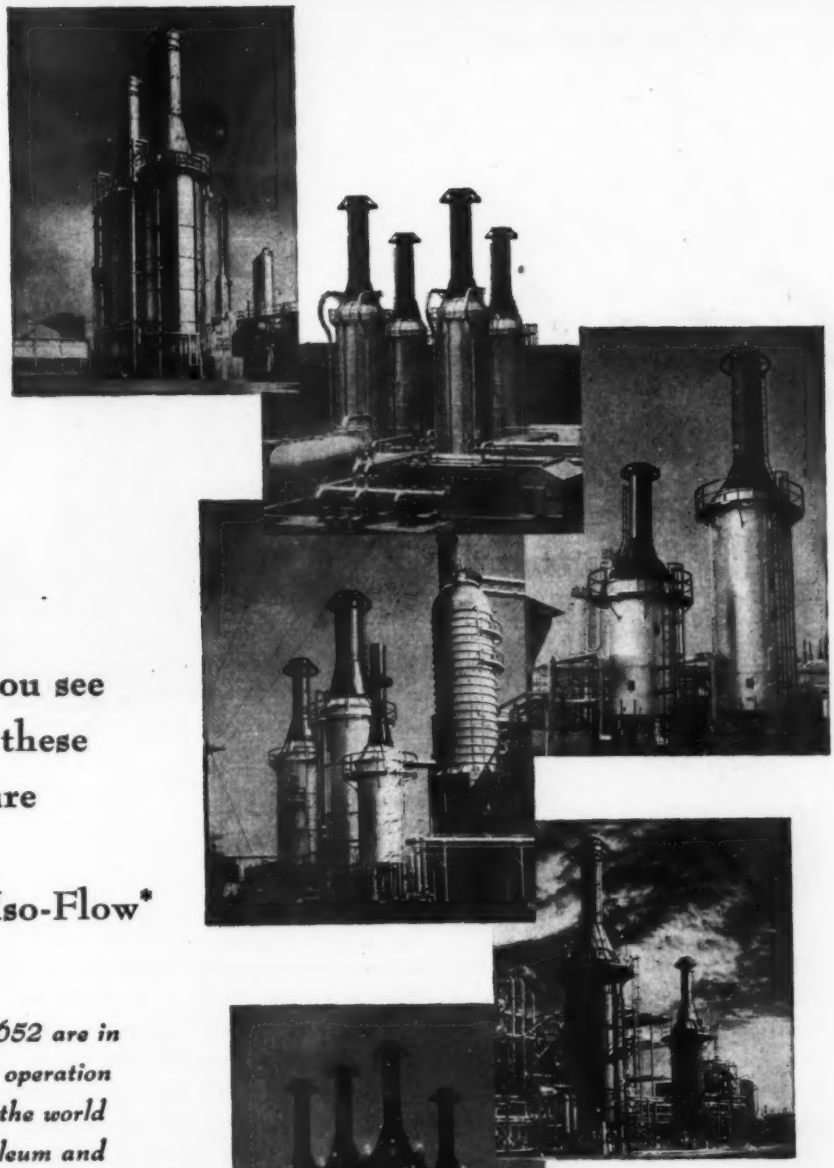


Fig. 6—Manufacture of acetic acid and acetic anhydride.



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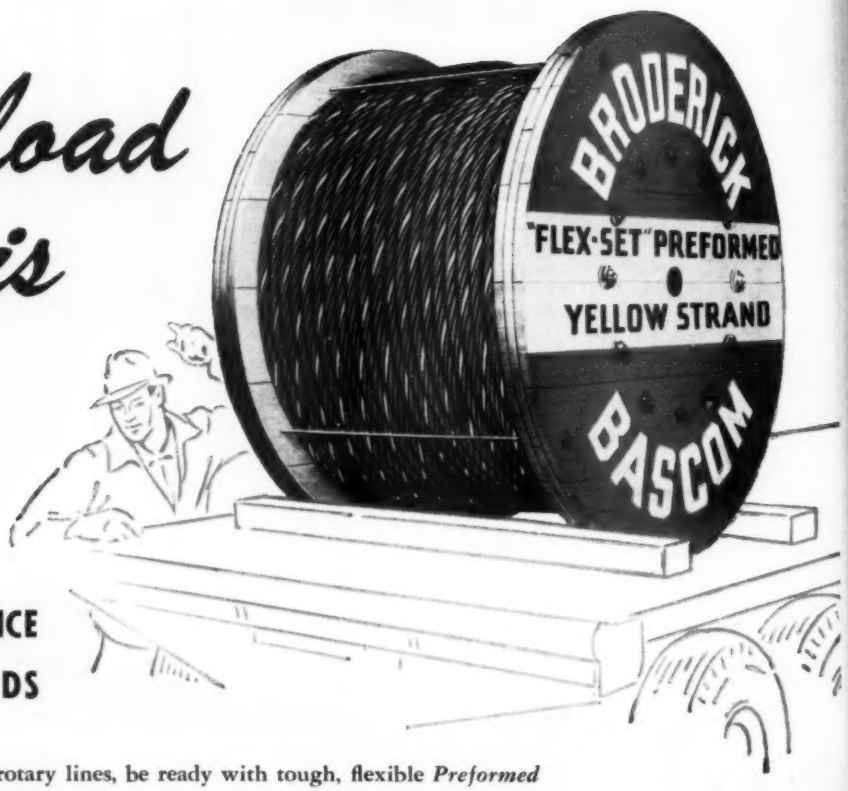

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trolled conditions to obtain a broad mixture of oxygenated hydrocarbons, including both formaldehyde and acetaldehyde.

Ethylene is one of the most important building blocks of the organic chemical business both because of its versatility and because of its ready availability. A few of the intermediates used in the polymer industry which can be produced from ethylene are shown in Fig. 5.

Ethylene oxide is produced either by adding hypochlorous acid to ethylene and subsequently removing hydrogen chloride, or by partial oxidation of ethylene with air under controlled conditions. Ethylene oxide may be hydrolyzed directly to ethylene glycol, a bifunctional alcohol which finds important uses in the production of ester-type polymers. It may also be converted to the cyanohydrin by the addition of hydrogen cyanide and then converted to either acrylonitrile or acrylic acid, two materials with a vinyl type of unsaturation useful in the manufacture of polymers.

Ethylene may also be reacted with hydrogen chloride to form ethyl chloride, used in the manufacture of ethyl-cellulose plastic, or it may be chlorinated and then dehydrochlorinated to vinyl chloride, a basic raw material for polyvinyl plastics and fibers.

A large amount of ethylene is used in the United States for the production of acetic anhydride, used in the manufacture of cellulose acetate fibers and plastics, and for the production of acetic acid, used in the manufacture of vinyl acetate. As illustrated in Fig. 6, ethylene is hydrated to ethanol either by reaction with sulfuric acid and subsequent hydrolysis of the acid sulfates formed, or by direct catalytic hydration. These processes are being used on a large scale in the United States. Much of the synthetic ethanol is then converted to acetaldehyde by catalytic oxidation or dehydrogenation.

Acetaldehyde may also be obtained by the direct hydration of acetylene, or by the oxidation of light paraffins, as mentioned previously. Very little acetaldehyde is used as such; it is usually oxidized directly to acetic acid or to a mixture of acetic acid and acetic anhydride.

Acetic acid is then converted to acetic anhydride by dehydrating half of it to ketene in a furnace and then combining the ketene with the other half of the acid to form the anhydride. In an alternate method of producing acetic anhydride, acetone is converted by thermal cracking in a furnace. The acetone, also used extensively as a solvent for synthetic fibers, is prepared by hydrating propylene to isopropanol with the aid of sulfuric acid, and then catalytically dehydrogenating the isopropanol.

The higher olefins, such as propylene and butylene, have uses other than conversion to alcohols and derivatives of such alcohols. Propylene may be chlorinated at high temperatures directly to the unsaturated product, allyl chloride. This may then be converted in a series of steps to glycerol, a trifunctional alcohol used in the manufacture of long-chain polyesters such as the alkyd resins. Normal butylenes may be oxidized under controlled conditions to maleic anhydride.

Aromatics are the base for many important organic chemicals, including some of the most important of the synthetic rubbers, plastics, and fibers. While aromatics have been obtained traditionally as byproducts from coal processing, the limitations of supply of some of these coal tar products have caused an increasing demand for these materials from petroleum sources. This trend will undoubtedly continue as the use of aromatics continues to increase.

Some of the important polymeric intermediates obtained from aromatic hydrocarbons are illustrated in Fig. 7. Benzene, presently obtained on only

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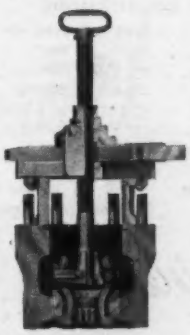

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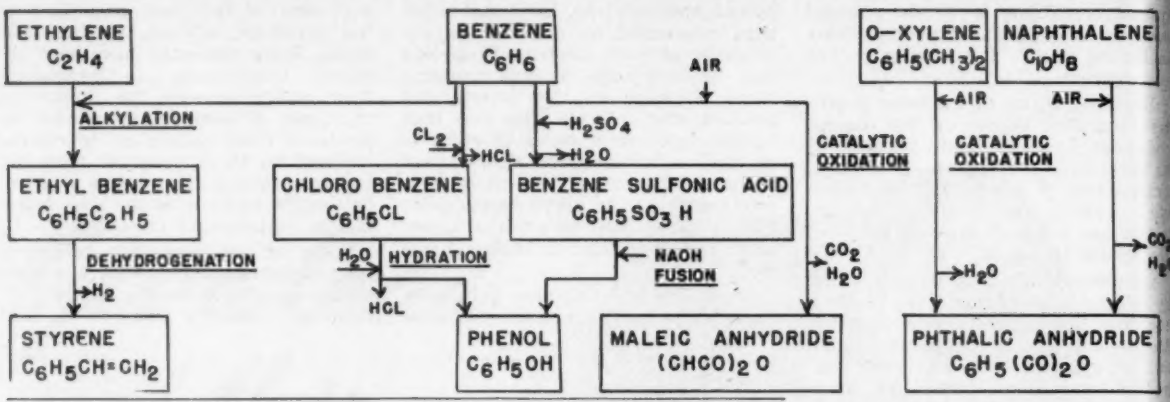

Fig. 7—Intermediates from aromatics.

a small scale from petroleum in the United States, is the most important of the aromatics for polymer manufacture.

Benzene is alkylated with ethylene to ethyl benzene, and this in turn is catalytically dehydrogenated to styrene in a manner similar to that used in producing butadiene from normal butylenes. Styrene is a basic raw material in the production of buna S, the so-called general-purpose synthetic rubber, and of polystyrene, an important plastic. Benzene is also converted by way of chlorobenzene or benzene sulfonic acid to phenol, most of which is used in the phenol-formaldehyde plastics.

The bifunctional acids, used extensively in the manufacture of polyesters such as the alkyd resins, are usually derived from aromatic hydrocarbons. Maleic anhydride is normally produced by the air oxidation of benzene over a metallic oxide catalyst, although it may also be made from normal butylenes, as previously mentioned.

Phthalic anhydride is obtained primarily by catalytic oxidation of naphthalene with air, but the catalytic oxidation of orthoxylene is also being carried out on a commercial scale. These catalytic oxidations, which require very close temperature control, can be carried out advantageously by the use of the fluidized solids technique.

Esso Books Available

NEW YORK.—Standard Oil Development Co., chief research affiliate of Standard Oil Co. (N.J.), will release some of its technical books for publication, the company announced last week.

To be known as the "Esso Series," the first volume, from the Esso Engineering Department, entitled "Data Book on Hydrocarbons," is now available. The second book, "Flow Measurement With Orifice Meters" will be published later this year.

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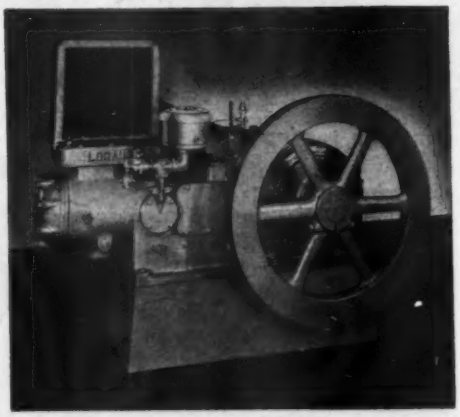

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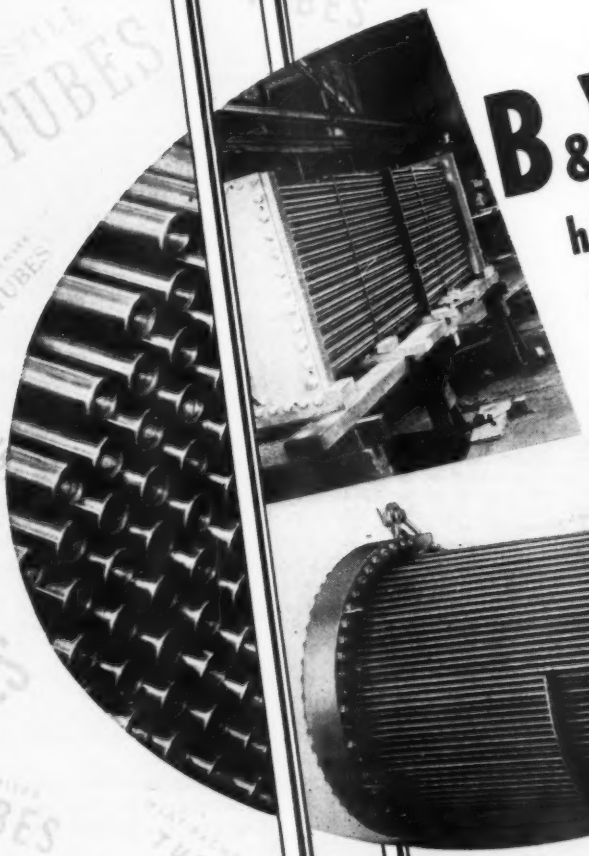

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TA-1523-C

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Resistivity and Saturation Distribution In Infiltrated Zones of Porous Formations around drill holes

by Dr. Leendert de Witte*

REFERENCE ENGINEERING SECTION

A method is outlined here by which the resistivity distributions in invaded zones of porous formations traversed by drill holes can be computed from successive measurements of core samples of which the initial fluid content is known and through which measured quantities of water are forced.

Resistivity profiles.—This method permits their computation through the invaded zones of water, oil, and gas sands. Existing data on the mobilities of interstitial waters of porous sands, upon flushing, are discussed and amplified by some experimental results.

Factors governing infiltrated zone saturations.—Their determination, for oil and gas sands, from a theoretical analysis of the displacement of oil and gas by water, during radial infiltration.

Experimental results.—Experiments were made on the relations between the water saturations of the invaded zones and those of the undisturbed formations in oil sands. From the results of these experiments, magnitude of the influence of oil viscosities and of pressure gradients during infiltration has been estimated.

Introduction

IN all attempts at quantitative evaluation of resistivity logs in drill holes, assumptions are made regarding the resistivity and the relative saturation of the zones invaded by mud filtrate.

To date, however, the literature does not contain any concise data on the actual distribution of resistivities in the invaded zones of porous formations.

This paper presents the results of experimental studies on the resistivity variations of core samples of varying initial fluid content, upon flushing by water of low salinity.

The resistivity measurements on the core samples after various stages of flushing have been used to determine the resistivity of points in invaded zones at varying distances from the bore face for given radii of infiltration.

From these data it is possible to construct resistivity profiles through the invaded zones of water, oil, and gas sands.

For proper interpretation of the resistivity data, it was found necessary to investigate some of the basic relations between resistivities and fluid contents of porous rocks.

Experimental Procedure

For all experiments, sandstone samples were used which were taken from outcrops. With the aid of a diamond saw and a rotary wire brush the samples were shaped to cylindrical cores approximately 2 in. in height and 2.8 in. in diameter.

*Division of Geological Sciences, California Institute of Technology, Pasadena.

Mounting.—These cores were mounted in the bottom part of a cylinder of a Baroid wall-building tester, using a thermosetting casting resin (castolite). The lid of the Baroid tester was connected to a nitrogen bottle via a reducing valve. A special adapter was machined to hold a porcelain disk which could replace the bottom part of the wall-building tester. The cylinder would fit onto this adapter and the connection was sealed by an "O" seal gasket.

A good contact between the standstone core and the porcelain disk was established by inserting a thin layer of ground porcelain between the bottom face of the core and the porcelain disk.

Saturating cores.—In this manner the cores could be saturated with oil or gas by the capillary pressure method. To do this the sample was first saturated with water. The cylinder containing the core was then placed in the sleeve of the adapter and a sufficient quantity of oil was poured into the cylinder above the core. After the lid of the Baroid tester was closed, pressure could be applied upon the oil, using the nitrogen bottle, while the water had a free outlet through the porcelain disk.

After an initial saturation was established, the fluid in the top of the Baroid cylinder above the core was replaced by fresh water and the adapter was replaced by the standard bottom part of the Baroid tester. By applying gas pressure, the fresh water would be flushed through the core.

At any stage after the initial saturation, the procedure could be interrupted to make a resistivity measurement of the sample.

Resistivity measurements.—These were made on the bottom face of the core using a system of four steel electrodes. The current between the current electrodes and the voltage drop between the two pickup electrodes were measured by an electronic voltmeter with an input impedence of 5 meg. ohm, which was sufficiently high to make the amount of current drawn by the measuring circuit completely negligible.

The measuring circuit is presented schematically in Fig. 1. The resistivities are found as:

$$R = K \frac{\Delta V}{I} \Omega \text{ cm.}$$

where K is a function of the geometrical spacings of the electrodes. The resistivities thus measured must be corrected for the effects of the walls of the core as the formulas connecting K with the electrode spacings are derived for semiinfinite media. The corrections for the physical dimensions of the cores were found empirically by measurements of electrolyte resistivities in cylindrical glasses of varying diameters and varying heights. The corrections to be applied to the measured resistivities in order to obtain the true resistivities are shown in Fig. 2.

The measurements of the resistivity of the samples after various stages of flushing give us the variation of the

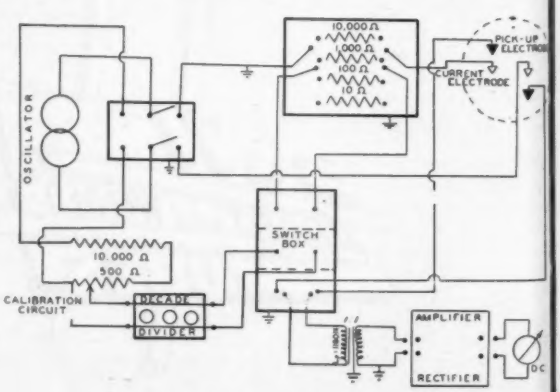

Fig. 1—Circuit used in resistivity measurements.

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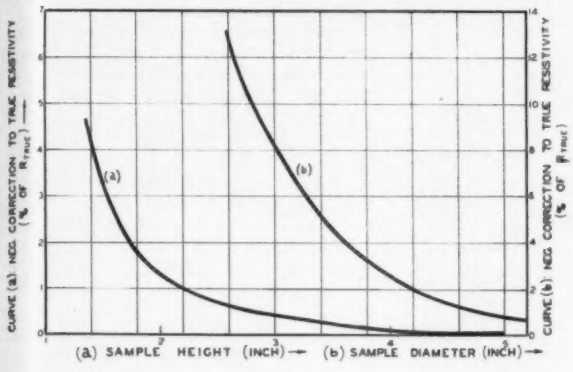
CURVE (a) NEG. CORRECTION TO TRUE RESISTIVITY (% OF R TRUE)
CURVE (b) NEG. CORRECTION TO TRUE RESISTIVITY (% OF R TRUE)
(a)
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(a) SAMPLE HEIGHT (INCH)
(b) SAMPLE DIAMETER (INCH)

Fig. 2

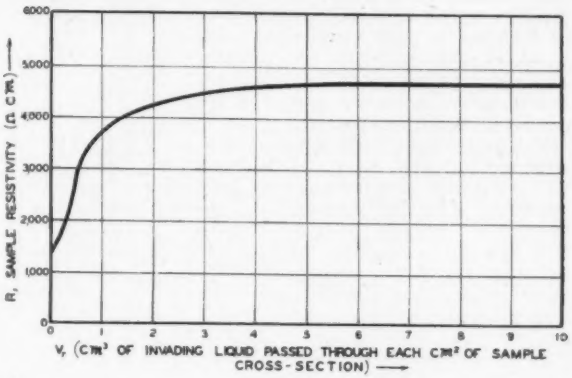

Fig. 5

resistivity of the rock as a function of the amount of invading fluid passed through a unit cross-section perpendicular to the direction of flow.

To obtain from these data the resistivities in the invaded zones of porous formations as a function of the radial distance from the bore face, we must compute the amounts of invading fluid passing through a unit cross-section of the formation, at various distances from the bore face.

This is done in the following manner: Consider a slice of 1 cm.² thickness of the bore hole and the infiltrated zone. In this slice we will limit our attention to a sector corresponding to 1 cm. circumference of the bore-hole cross-section (see Fig. 3). The intersection of this sector

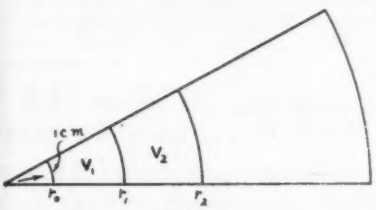

Fig. 3

with the bore face has a surface area of 1 cm.² We now divide this sector into volumes V_1, V_2, etc., by arches concentric with the bore hole, corresponding to equal increments in the radial distance from the axis of the hole, r.

In each of the volumes we assume the amount of invading fluid retained per unit pore space (X) to be constant. If the amount of invading fluid retained in Volume V_1, expressed as a fraction of the pore space is denoted by X_1, in volume V_2 by X_2, etc., we assume as a first approximation that $X_1 = (X)_{r_0}$, $X_2 = (X)_{r_1}$, etc., where $(X)_{r_0}$ and $(X)_{r_1}$ are the actual values of X respectively at the radial distances r_0 and r_1 from the axis of the hole. This assumption means that in each volume we make X equal to its actual value at the inner boundary of the volume.

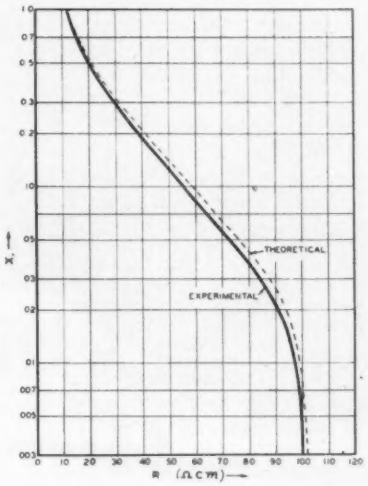

Fig. 4

Using these assumptions we have:

Amount of invading fluid retained in

$$V_1 = \frac{r_1^2 - r_0^2}{2r_0} \times f \times (X)_0$$

where f is the fractional porosity and

$$\frac{r_1^2 - r_0^2}{2r_0} = \frac{1}{2\pi r_0} \times \pi (r_1^2 - r_0^2) = V_1$$

If $(v)_{r_0}$ is the total quantity of invading liquid entering the sector through its 1 cm.² cross-section at the bore face we may write:

Amount of filtrate flowing into

$$V_2 = (v)_{r_0} - \frac{r_1^2 - r_0^2}{2r_0} f\,(X)_{r_0}$$

and the amount of invading liquid entering V_2 per cm.² of its inner boundary is:

$$(v)_{r_1} = r_0/r_1 \left[(v)_{r_0} - \frac{r_1^2 - r_0^2}{2r_0} f\,(X)_{r_0} \right]$$

If in general we denote the amount of invading liquid entering volume V_n per cm.² of its inner boundary, by $(v)_{r_n}$, we have:

$$\frac{r_{n+1}}{r_0}(v)_{r_{n+1}} = \frac{r_n}{r_0}\left[(v)_{r_n} - \frac{(r_{n+1})^2 - r_0^2}{2r_0} f\,(X)_{r_n} \right] \quad (1)$$

The amount of invading liquid retained per unit pore space, X_r, is found as a function of the amount of filtrate passed through the specimen per unit cross-sectional area, v_r, by quantitative analysis of the resistivity measurements after various amount of infiltration. The analyses of the resistivity measurements will be discussed in the following paragraphs.

Equation 1 is a recurrence formula. If we know or assume $(v)_{r_0}$ we can compute successively $(v)_{r_1}$, $(v)_{r_2}$, etc., which enables us to plot (v_r) as a function of r.

Another approximation of this relation can be made by assuming $X_1 = (X)_{r_1}$, $X_2 = (X)_{r_2}$, etc., that is making X in each volume equal to its actual value at the outer boundary of the volume in question.

The actual conditions will result in a relation which falls in between the two approximations determined above and may be represented by averaging the graphs obtained for the two approximations.

From the graph giving v_r as a function of r and the measured values of R for successive values of v_r we finally obtain R as a function of r; that is, we find the formation resistivity as a function of the radial distance from the axis of the drill hole.

Examples of the relationships computed as intermedate steps in the determination of the resistivity profiles are given in Figs. 5, 6, and 7, for the case of the invasion of a salt-water sand by a less saline mud filtrate.

Resistivity Distributions in Invaded Zones of Water Sands

In the above discussion it was shown that in order to compute resistivity

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profiles of invaded zones of porous formations, it is necessary to determine which fraction of invading liquid is retained after a given amount of flushing. In other words we want to know how effective the replacement of connate water by the invading water is, when we deal with invasion of water sands.

The question of the mobility of connate waters upon flushing has been dealt with by several investigators but the conclusions arrived at by independent workers have not been combined in a concise manner. As the question is of considerable importance for the quantitative analysis of resistivity data, we will briefly review preceding work on the subject and present some additional experimental data to support the general conclusions.

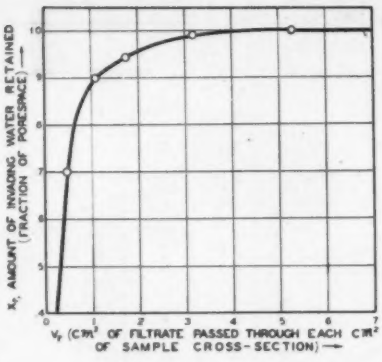
X_r, AMOUNT OF INVADING WATER RETAINED (FRACTION OF PORESPACE)
V_f (CM³ OF FILTRATE PASSED THROUGH EACH CM² OF SAMPLE CROSS-SECTION)

Fig. 6

Until recently it was generally accepted that when a porous rock was saturated 100 per cent with an electrolyte, the resistivity of the rock could be expressed as:

$$R_o = F R_w \qquad (2)$$

where R_w is the electrolyte resistivity. F was assumed to be a constant independent of R_w and is termed the formation factor. Physically F has the same meaning as the cell constant in electrolyte conductivity measuring cells.

In the early part of the experiments connected with this work, it was noticed that if a sample was first saturated with an electrolyte of low resistivity and then flushed with large quantities of a less saline solution, the resulting resistivity invariably was lower than the value computed from Equation 2.

Tixier,[1] comparing resistivities of invaded zones with those of the undisturbed formations in the field, noticed this same phenomenon. He explained the low resistivities after invasion (or flushing) by assuming that a part of the saline connate water was not removed. The mixture of the retained saline water with the less saline mud filtrate would give a lower resistivity of the invaded zone than that resulting from complete replacement of the connate water by the mud filtrate.

Both from Tixier's work and from our experiments it appeared that different rocks exhibited the phenomenon to different extents. Clean sandstones showed a very small "retention," while shaly sands or sandstones with a large percentage of fines gave a much larger effect.

The connate - water - retention hy-

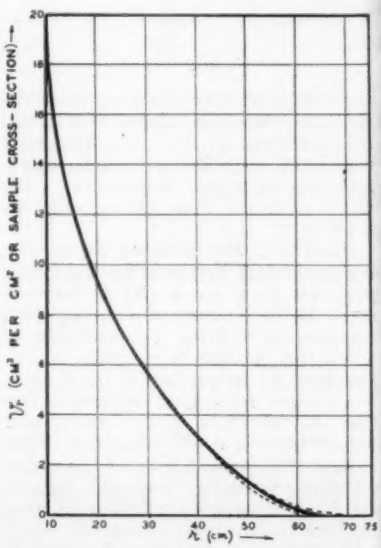

Fig. 7

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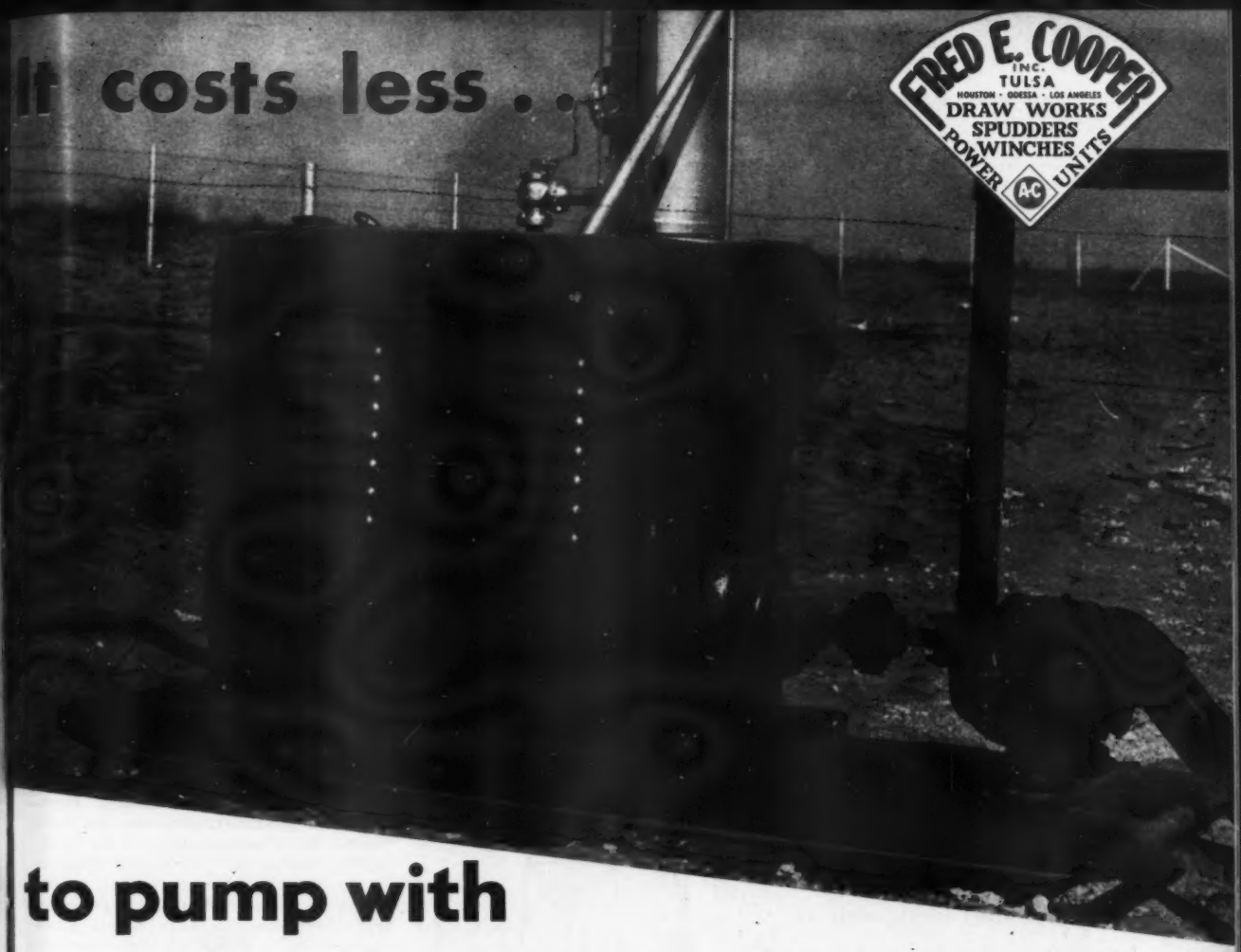

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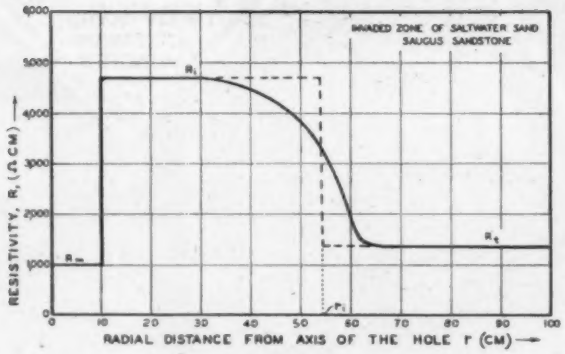

Fig. 8

pothesis did not seem to be in agreement with the results of the work by Morgan, Muskat, and Russell,[2] who experimented on the mobility of interstitial water in sandstones, using both radioactive tracers and NaCl as indicators.

They found that for the particular sandstone used in their experiments (Nichols Buff sandstones), all of the connate water was replaced after an amount of invading water approximately equal to 10 times the pore volume had been passed through the sample.

The possibility existed, however, that the sandstone used by the above authors was a particularly inert sandstone where the "retention effect" would be negligible.

This was shown not to be the case by Patnode and Wyllie[3] in a recent publication. These authors made a large series of experiments using NaCl as a tracer and among the samples studied were Nichols Buff sandstones. Patnode and Wyllie attributed the apparent decrease in the formation factor with increasing interstitial water resistivity to the influence of conductive solids which are present in most sandstones.

To prove that complete replacement of interstitial water takes place upon flushing with sufficient quantities of other aqueous solutions, they measured the resistivities of an artificial core, made up from alundum, which contains no conductive solids. For this case no lowering of the formation factor was found with increase in water resistivity and this was taken as proof of the complete replacement of the interstitial waters in porous media, upon flushing. However, the alundum core can be compared to a completely clean sand, which would not retain any fraction of its connate water according to the connate - water - retention hypothesis, and therefore this experiment gives no conclusive proof of the complete replacement of interstitial water in sandstones in general.

In order to decide definitely whether or not the connate water originally present is completely replaced upon flushing in average sandstones, the following experiments were made:

Two samples of sandstones for which the variations in the formation factor had been found to be especially large, were first saturated with a

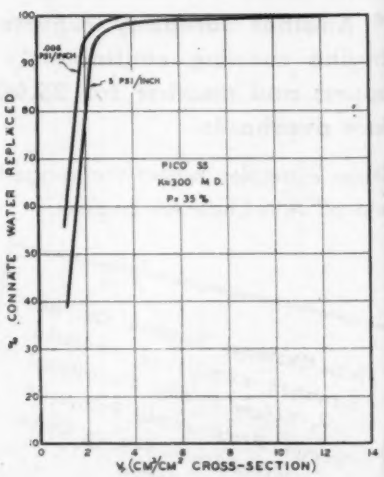

Fig. 9

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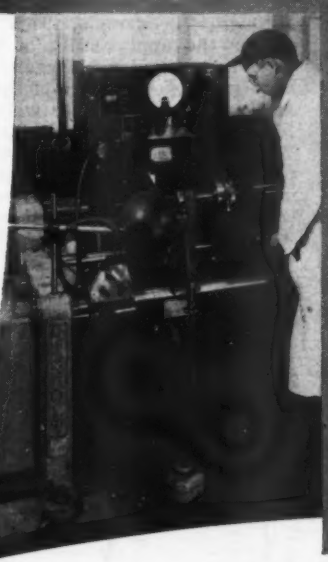

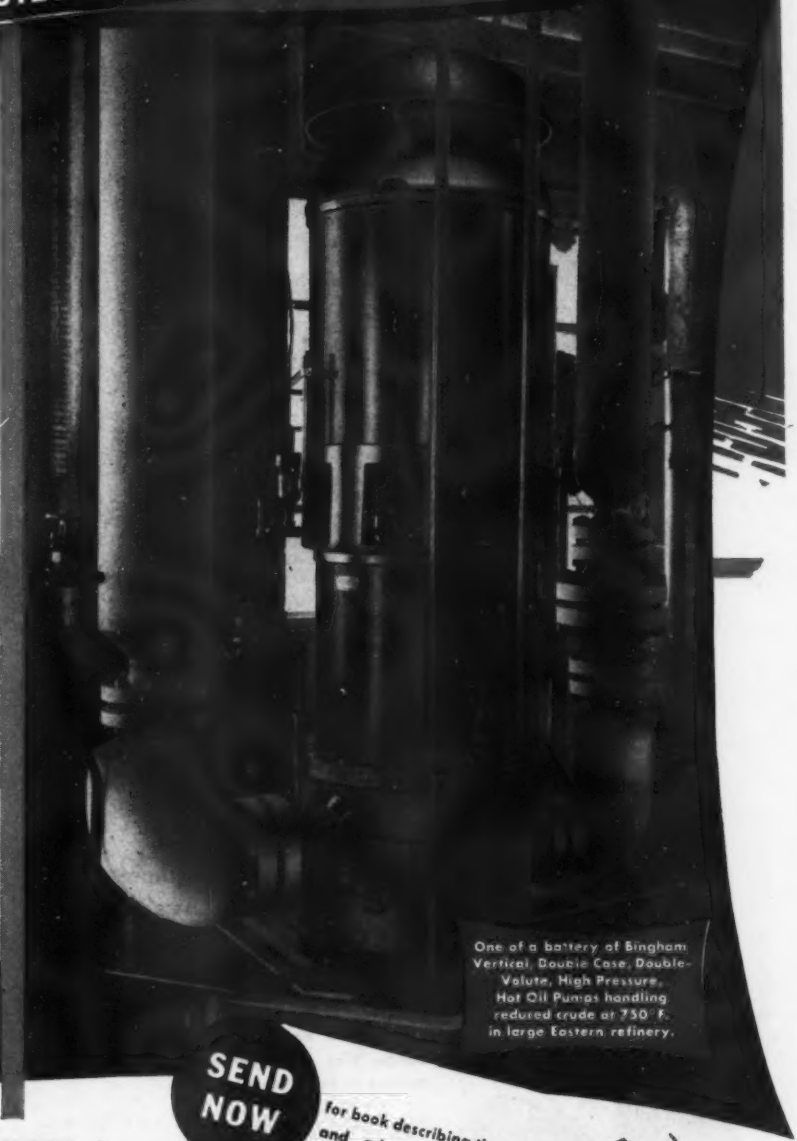

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concentrated NaCl solution of approximately 1N. Following this, less saline water was forced through the samples and the resistivity of the effluent mixture was measured. The effluent water is a mixture of the original interstitial water and the water used for flushing. By measuring its resistivity at intervals and knowing the resistivity of the two components we can calculate the fractions of each component present in the mixture using the formula:

$$R_e = \frac{R_1 R_2}{R_1 + X_1 (R_2 - R_1)} \quad (3)$$

Here R_e, R_1, and R_2 are respectively the resistivities of the mixture, the original interstitial water, and the invading water. X_1 is the volume fraction of the original interstitial water in the mixture.

Formula 3 follows directly from the assumption that resistivities of electrolytes are inversely proportional to their concentrations. This assumption gives a good approximation for dilute solutions. To test the validity of Equation 3, experimentally determined resistivities of mixtures of the solutions used for one of the two tests were compared with values computed from this equation. The results, shown in Fig. 4, prove that even for fairly concentrated solutions Equation 3 still gives a reasonable approximation.

Table 1 shows the amounts of connate water retained in the samples expressed as a fraction of the pore space, after various amounts of flushing.

The examples show clearly that the original interstitial water is completely replaced after an amount of invading water approximately equal to 10 times the pore volume has passed through the sample. This demonstrates the applicability of the conclusions reached by Morgan, Muskat, and Russell to all types of sandstones and makes the connate water-retention hypothesis definitely untenable. We will therefore accept the very plausible explanation for the lowering of the apparent formation factor, with increase in interstitial water resistivity offered by Patnode and Wyllie.

The latter authors also demonstrated that the resistivity of water saturated sandstones can be expressed by an equation of the form:

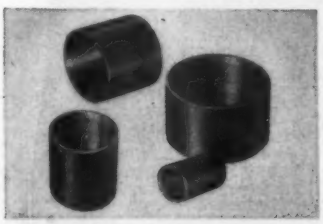
$$1/R = y + z/R_w \quad (4)$$

where y depends upon the amount

TABLE 1—CONNATE WATER RETAINED IN CORE SAMPLES, AS FRACTION OF PORE SPACE

Symbils: V_1 = amount of invading water passed through sample
S_c = amount of original interstitial water retained in sample

Saugus sandstone			Modelo shaly sandstone		
	V_1	S_c per cent		V_1	S_c per cent
Cm.³	Pore volumes	of pore space	Cm.³	Pore volumes	of pore space
25	1.16	20.9	47	1.45	30.8
50	2.32	9.9	97	2.98	12.5
75	3.48	5.8	202	6.22	2.4
129	6.0	1.02	342	10.5	0.28
207	9.62	0	421	12.96	0
			436	13.4	0



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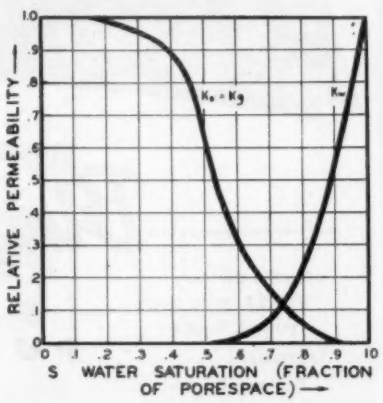

Fig. 10

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and the bulk resistivity of the conductive solids present and z is a function of the effect of the solid framework on the current conduction through the water.*

After y and z have been computed for a given sandstone from two corresponding measurements of R and R_w, we may calculate R_w for any other value of R.

Thus upon flushing a sample originally containing saline interstitial water, with a less saline solution, we can find the resistivity of the water mixture (R_c) in the interstices at any time by measuring the sample resistivity.

From the computed values of R_c we can calculate the amount of invading liquid retained in the sample, using Equation 3. For this purpose Equation 3 may be rewritten as:

$$X_2 = 1 - X_1 = \frac{1 - R_1/R_c}{1 - R_1/R_2} \quad (5)$$

where R_1, R_2, R_c, and X_1 are defined as for Equation 3 and X_2 is the amount of invading liquid retained in the sample as a fraction of the total pore space.

*A detailed discussion of Equation 4 will be given in a paper on the relations between resistivities and fluid contents of porous rocks now being prepared for publication.

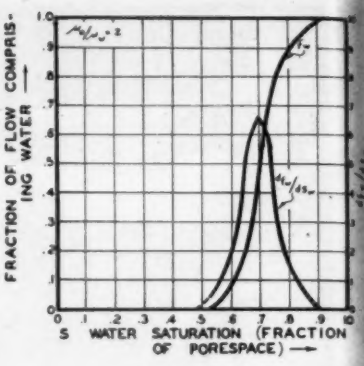

Fig. 11

Fig. 5 shows the sample resistivity R_1 for a core of Saugus sandstone as a function of the amount of invading liquid passed through 1 cm.² of cross-sectional area of the sample (v_r).

Fig. 6 gives X_r ($\equiv X_2$) as a function of v_r. Using this relation between X_r and v_r we may compute v_r as a function of r with the aid of Equation 1. The results of this computation are shown in Fig. 7.

Finally, using the data of Figs. 5 and 7, we may plot the resistivity R as a function of the radial distance from the axis of the drill hole, r. This is done in Fig. 8 assuming the drill-hole radius r_o = 10 cm. and $(v)_{r_o}$ = 20 cm.³/cm.² of bore face.

Fig. 8 represents the actual resistivity profile through the invaded zone of a water-saturated Saugus sandstone after invasion has progressed until an invaded-zone radius of 54 cm. (= 5.4 r_o) has been reached. We see from Fig. 8 that the resistivity in the infiltrated zone is not a constant throughout the entire zone and that the outer boundary is not a sharp discontinuity of the resistivity distribution. For all practical purposes we can, however, replace the transition zone by two parts of constant resistivity, separated by a discontinuity, as indicated by the dashed lines in Fig. 8.

Fig. 8 represents a profile for average infiltration. For larger amounts of infiltration, the transition zone remains practically unchanged, while the zone of constant resistivity becomes larger. In such cases the approximation made by representing the actual resistivity distribution by

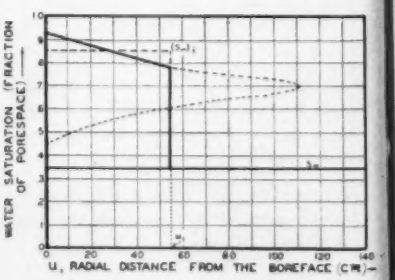

Fig. 12

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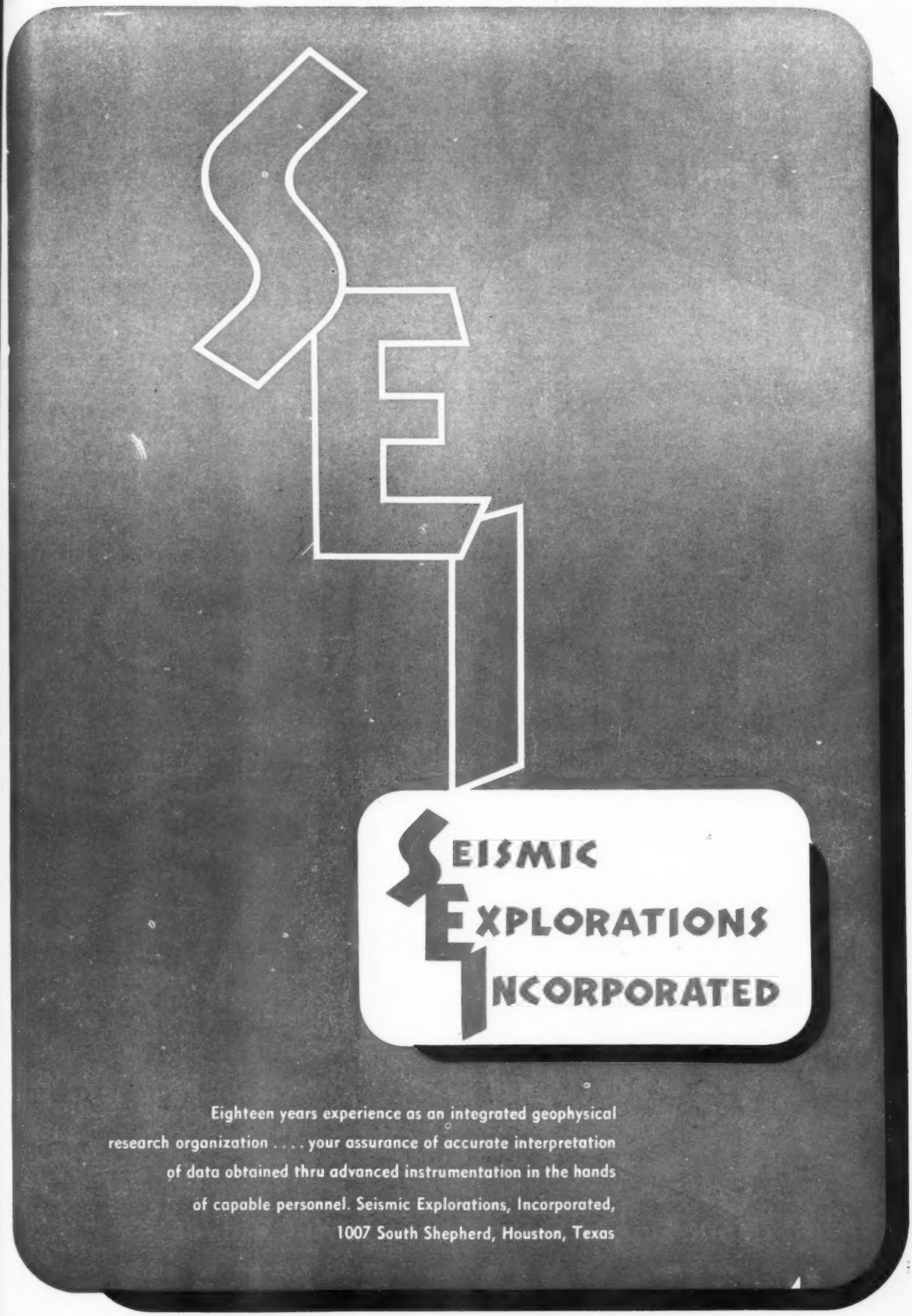

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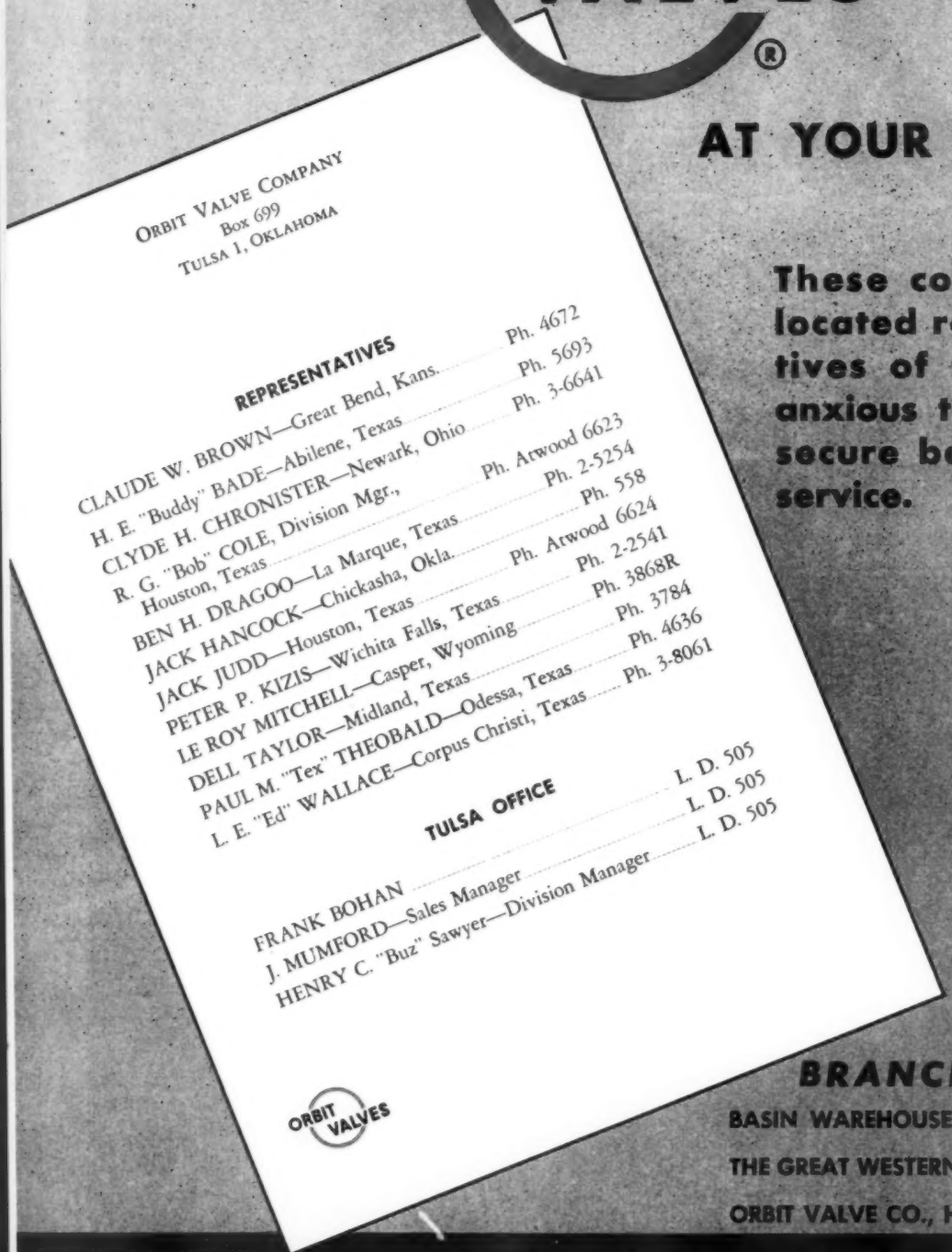

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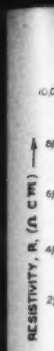

RESISTIVITY, R, (Ω C M)

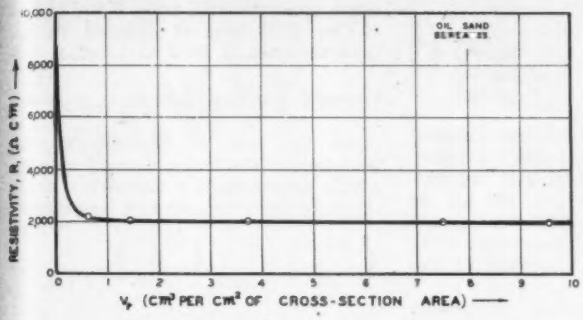


Fig. 13

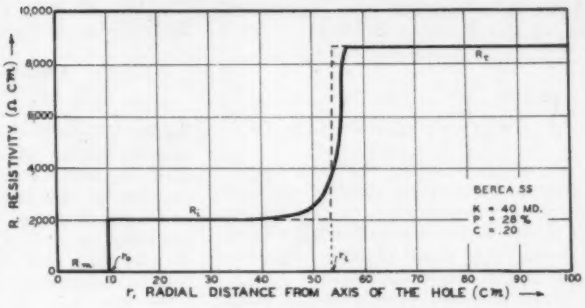


Fig. 14

a constant invaded-zone resistivity, R_i, becomes better.

For smaller radii of infiltration the zone of constant resistivity becomes smaller and the approximation used for purposes of interpretation becomes less accurate.

As replacement of the saline solution originally present by the mud-filtrate may be partly attributed to diffusion of the salt ions into the invading liquid, it is reasonable to expect that the rate of infiltration has a direction bearing on the resistivity distribution in the invaded zone.

This assumption was checked by invading samples of the same type of sandstones, under the application of different pressure gradients. Fig. 9 gives an example of the effect of the rate of infiltration upon the rate of replacement of the connate water for a Pico sandstone (permeability ≈ 300 md.).

Analysis of Displacement of the Non-wetting Phase Upon Invasion of Oil and Gas Horizons

The mechanism of oil and gas displacement in sands by unidirectional invasion of water has been treated by Buckley and Leverett.[4]

The analysis makes use of the relative permeabilities of the rock to the fluids involved.

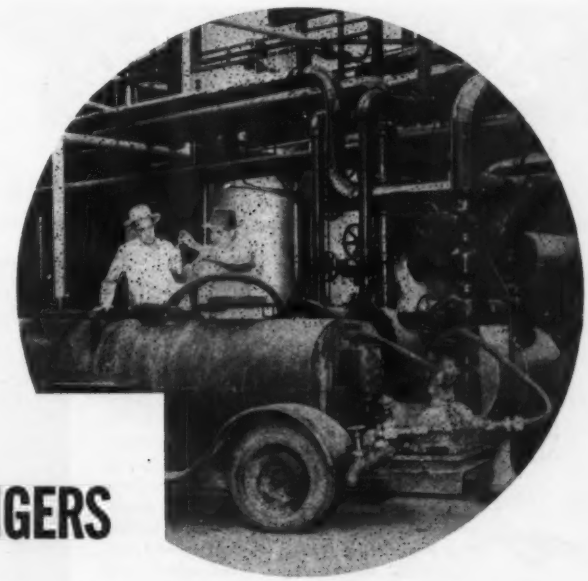
The basic relation upon which the derivation is based is a material balance for a unit volume which may be stated as follows:

The net rate of accumulation of the displacing fluid which is equal to the net oil (or gas) displacement in any given volume will be proportional to the difference between the rate at which the displacing fluid enters the volume and the rate at which it leaves the same volume.

If u indicates length in the direction of the fluid flow and f_w is the fraction of the fluid flow comprising the displacing liquid we may write:

$$\left(\frac{\partial S_w}{\partial \theta}\right)_u = \frac{-q_T}{A\psi}\left(\frac{\partial f_w}{\partial u}\right)_\theta$$

where S_w is the water saturation, θ denotes time. q_T is the total fluid flow, ψ the fractional porosity, and



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A the cross-sectional area perpendicular to the direction of flow.

This may be reworked to:

$$\left(\frac{\partial u}{\partial \theta}\right)_{S_w} = \frac{q_r}{A\psi}\left(\frac{\partial f_w}{\partial S_w}\right)_{\theta} \quad (6)$$

Equation 6 states that the rate of advance of a plane where S_w is constant is proportional to the change of composition of the flowing stream, caused by a small change in saturation of the displacing fluid.

Neglecting the effects of capillarity and gravity, f_w is related to the properties of the system in the following manner:

$$f_w = \frac{K_w/\mu_w}{K_w/\mu_w + K_o/\mu_o} = \frac{1}{1 + \dfrac{K_o/\mu_w}{K_w/\mu_o}} \quad (7)$$

where K_w and K_o are the relative permeabilities of the rock to water and oil and μ_w and μ_o are the viscosities of the water and the oil. In the case of a gas sand K_o and μ_o are replaced by the relative permeability to gas (K_g) and the viscosity of the gas (μ_g) respectively.

In the case of radial infiltration the same principles apply, only we have to take into account the change in rate of flow with the radial distance from the drill hole. If the radius of the drill hole is denoted by r_o, then the rate of flow at a radial distance, u, from the bore face, is $\dfrac{r_o}{r_o + u}$ times the rate of invasion at the bore face. Considering a small volume whose center is at a distance u from the bore face, Equation 6 becomes:

$$\left(\frac{\partial S_w}{\partial \theta}\right)_u = \frac{-q_r}{A\psi}\left(\frac{\partial f_w}{\partial u}\right)_{\theta}\frac{r_o}{r_o + u} \quad (8)$$

Here A is the surface of the bore face through which a flow of q_r cm.^{3} per second prevails.

As in the case of unidirectional flow, Equation 8 may be reworked to:

$$\left(\frac{\partial u}{\partial \theta}\right)_{S_w} = \frac{q_r}{A}\left(\frac{\partial f_w}{\partial S_w}\right)_{\theta}\frac{r_o}{u + r_o}$$

or in terms of the total amount of invading liquid that has entered the system (Q_r)

$$\int_0^u (u + r_o)\,du = \frac{r_o}{\psi A}\left(\frac{df_w}{dS_w}\right)_{\theta}\int_0^{\theta} q_r\,d\theta$$

which gives:

$$\frac{u^2}{2} + u\,r_o + c = \frac{r_o}{\psi A}\left(\frac{df_w}{dS_w}\right)Q_r \quad (9)$$

For $Q_r = 0$, that is before infiltration has started, S_w is equal to the connate-water saturation of the undisturbed formation. The discontinuity in the water saturation at the bore face may be replaced by a continuous series of S_w ranging from its actual value in the formation to 1.0 in the drill hole between $u = +0$ and $u = -0$. This means that all values of S_w later encountered in the invaded zone originally prevail at $u = 0$.

From these initial conditions ($u = 0$ for $Q_r = 0$) we find from Equation 9 that $c = 0$.

Solving Equation 9 for u gives:

$$u = \left[r_o^2 + \frac{2r_o}{\psi A}\left(\frac{df_w}{dS_w}\right)Q_r\right]^{1/2} - r_o \quad (10)$$

where f_w is given by Equation 7.

For a given amount of infiltration (Q_r) we can calculate therefore at which distance from the bore face an arbitrary saturation will prevail, if the initial saturation and the relative-permeability-versus-saturation relationships are known.

Fig. 10 gives the relative-permeability relations for the Nichols Buff sandstones as determined by Botset.[5] Fig. 11 shows f_w and df_w/dS_w, derived from these relations for $\mu_o/\mu_w = 2$, as functions of S_w.

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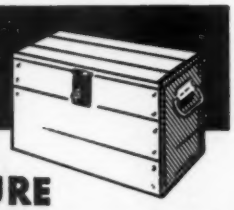

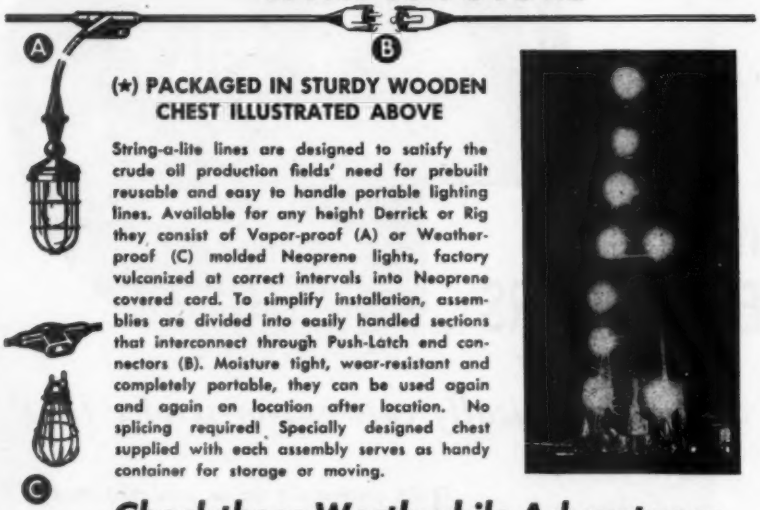

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S_w from Fig. 11 and applying Equation 10, we have computed the infiltration zone saturation distribution assuming the original water saturation $(S_w)_o = 0.35$, $Q_T/A = 25$ cm.³/cm.², $r_o = 10$ cm. and $\psi = 0.25$.

The results are shown in Fig. 12. We see that the curve for S_w versus u is multiple valued for all values of u.

Buckley and Leverett obtained a similar result for the case of unidirectional flow, Obviously this result is a physical impossibility. As pointed out by Buckley and Leverett the correct interpretation is that a portion of the curve is imaginary and that the real saturation-versus-distance graph is discontinuous with a discontinuity at a certain point u_i.

To find u_i we must make a new material balance based on the fact that in the sector under consideration the total inflow equals the fractional increase in water saturation times the pore volume in which the increase takes place.

This gives:

$$\int_0^{u_i} \frac{r_o + u}{r_o} \times \Delta (S_w)_o \, du = \frac{Q_T}{A\psi}$$

After plotting the integrand, u_i is found such that the area under the integrand between the ordinates through $u = 0$ and $u = u_i$ equals $Q_T/A\psi$.

For the case of Fig. 12 we find $u_i = 54.8$ cm.

Due to the effects of capillarity the actual saturation graph will have no sharp discontinuity but the corners will be somewhat rounded.

The discontinuity (or the steep part) of the saturation distribution curve coincides with what is termed the outer boundary of the invaded zone.

From the foregoing derivation, it is evident that the computation of the saturation distribution depends strongly on the accuracy with which the relative permeability-saturation relations are known, especially in the region of the small permeabilities to the nonwetting phase.

In the opinion of this author, most relative permeability data are not accurate enough in the regions where the permeabilities to oil or gas approach zero to obtain a good quantitative representation of the actual saturation distribution in invaded zones, using the above derivation. The derivation merely shows qualitatively some of the characteristics of the saturation distributions and the factors involved in determining them.

The most important conclusion that can be drawn is that the invaded-zone saturations depend upon the viscosity ratio of the nonwetting phase and the invading liquid, and on the relative permeability-versus-saturation relations.

Leverett[8] showed that for a given porous medium the location of the relative-permeability graphs will vary with the applied pressure gradient.

It is to be expected, therefore, that the invaded-zone saturation for a given formation is dependent upon the pressure gradient under which infiltration takes place.

Resistivity Profiles Through Invaded Zones of Oil and Gas Sands

The resistivity distribution in the invaded zones of oil sands depends upon two factors. The first is the displacement of part of the oil by the invading fluid; the second is the replacement of the connate water by the mud filtrate.

As the displacement of the oil does not depend upon the resistivity of the invading mud filtrate, its effect on the resistivity can be found by using a mud filtrate of the same salinity as the connate water.

We can further simplify the procedure of obtaining the variations in oil saturation from the resistivity measurements by using very saline connate water. It has been shown by this author* that if the connate-water resistivity is sufficiently low so that the effect of conductive solids on the resistivity can be neglected, Archie's formula may be used to find

*See footnote on page 256.

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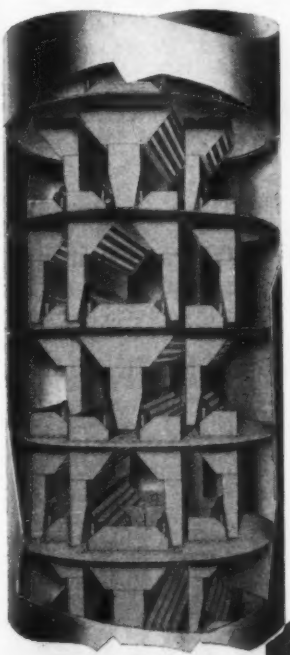

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the water saturation, S_w. In other words we may write:

$$S_w = \left(\frac{R_o}{R}\right)^{1/n} \text{ with } n = 2 \quad (11)$$

where R_o is the resistivity for the sand when 100 per cent water saturated, and R is the resistivity at the prevailing oil saturation $S_o = 1 - S_w$.

R_o is measured before the sand is saturated with oil. After the sand is saturated with oil, by the capillary-pressure method, we can measure the initial value of R and upon flushing we measure the changes of R as a function of the amount of invading liquid passed through the sample (v_r). This relation is given for a sample of Berea sandstone in Fig. 13.

Subsequently we find the values of S_w corresponding to the measured values of R using Equation 11. Subtracting from these values of S_w the initial water saturation before flushing was started, gives the amount of invading water retained as a fraction of the pore space. X_r. Having plotted X_r versus v_r we obtain v_r as a function of r, and finally R as a function of r in exactly the same manner as was outlined for the case of invasion of a water sand.

Fig. 14 shows the resistivity profile for the invaded zone of a Berea oil sand, thus computed. Fig. 15 gives the same relation for an oil-saturated Saugus sandstone.

The bound-water content of the Saugus sandstone equals 0.63 and the porosity 0.11 in contrast to the Berea sandstone which has a bound-water content of 0.18 and an average porosity of 0.25. We see that for sandstones of high bound-water content and low porosity, the transition zone of the resistivity profile is quite important.

On the other hand, for sands of low bound-water content and high porosity, the transition zone becomes completely negligible.

Again for larger infiltration radii, the constant part of the resistivity profile becomes relatively more important, while for smaller radii of invasion the approximation of the resistivity distribution in the invaded zone by a constant R_i becomes poorer.

If, as is usually the case, the mud filtrate is less saline than the connate water, we have superimposed on the effects of oil displacement the resistivity changes due to the replacement of the connate water.

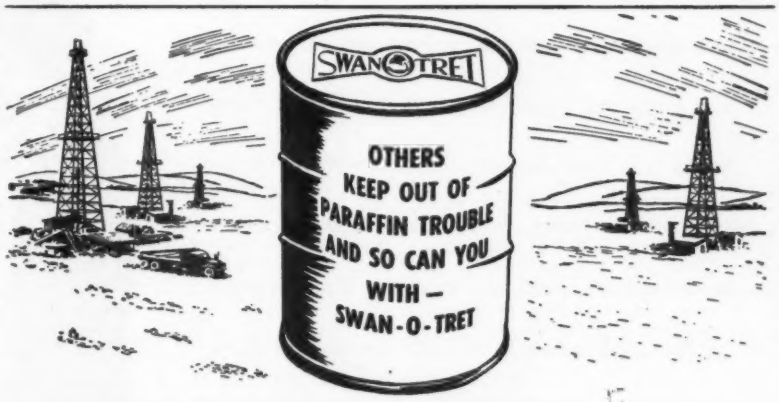
These two effects are of opposite sign and may be of almost equal magnitude, so that for many oil sands the resistivity of the invaded zone does not differ much from the true resistivity of the formation.

The computation of the resistivity distributions in the infiltrated zones becomes considerably more complicated than for the cases where the mud filtrate was kept identical to the connate water.

For this reason an experiment was made using a sample of Berea sandstone for all practical purposes identical to the one used in the preceding experiment. Also the initial oil saturation and the pressure gradient during the flushing were made as nearly as possible the same as in the foregoing experiment. For these conditions the amount of oil displaced after a given amount of invading water has passed through the sample is the same in both cases. Therefore the water saturation during any stage of the flushing can be found from the data obtained in the preceding experiment.

The amount of invading water retained in the sample will at all times be equal to the amount of oil displaced plus the amount of connate water replaced.

The latter is found by first determining the interstitial water resistivity R_w from the sample resistivity and the prevailing water saturation. After R_w is computed, we apply Equation 5 to determine which fraction of the interstitial water mixture consists of invading liquid. This fraction multiplied by the water saturation, S_w, gives use the amount of



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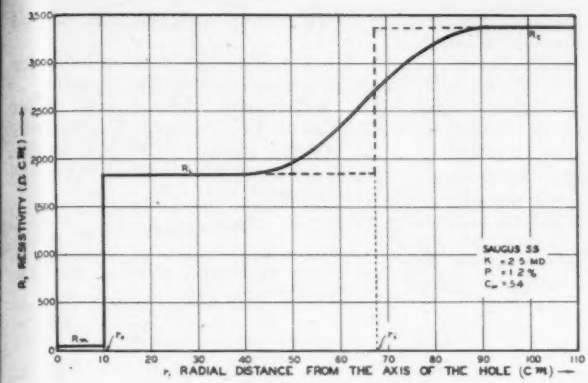

Fig. 15

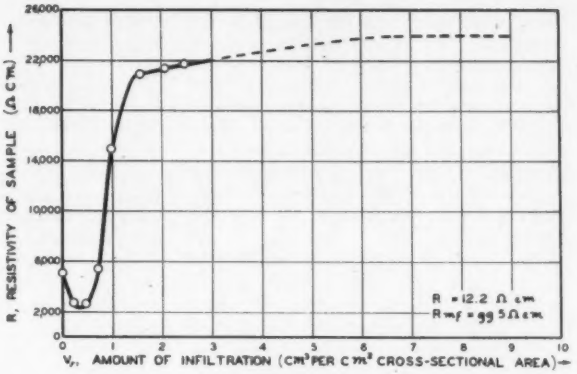

Fig. 16

invading water retained as a fraction of the pore space (X_r).

After X_r has been found as a function of the amount of invading water passed through the sample (v_r), the computation of the resistivity distribution in the invaded zone follows the same steps as described before. Fig. 16 gives R as a function of v_r for the case of the invasion of an oil sand with saline connate water by a much less saline mud filtrate. Fig. 17 gives the resistivity profile through the invaded zone for such a case.

We see from Fig. 16 that upon invasion the resistivity of the sample first decreases, goes through a minimum, and then sharply increases. This is caused by the fact that the oil is replaced more rapidly than the connate water.

Fig. 17 shows that the infiltrated zone resistivity, R_i, may be much higher than the true formation resistivity, if the salinity contrast between the connate water and the mud filtrate is large enough. In our example, $R_{mf}/R_w = 78.5$. In many practical cases the contrast will be much smaller and R_i and R_t may be very nearly equal.

The analysis made for the displacement of oil upon invasion applies equally well to the displacement of gas in the invaded zone of gas sands. The only important difference lies in the fact that the viscosity ratio for the combination gas-water is much smaller than for the oil-water combination. Due to the small viscosity of the gas, the rate of flow or displacement of the gas will still be noticeable in the region where the relative permeability of the rock to gas has become almost zero.

Fig. 18 shows a resistivity profile through the invaded zone of a gas sand. We notice that the resistivity changes continuously with the radial distance through the larger part of the invaded zone and that the transition at the outer boundary of the zone is quite sharp. The total magnitude of the resistivity variation between the transition zone and the bore face is, however, relatively small, so that we still can approximate the actual resistivity distribution by a constant resistivity R_i.

Relation Between Water Saturation of Invaded Zone and of the Undisturbed Formation in Oil and Gas Horizons

From computations based on resistivity log data, Tixier[1] showed that a relation exists between the amount of oil retained upon invasion of an oil sand and the amount of oil initially present in the sand.

That such relation does exist may be explained as follows: The amount of oil retained upon flushing depends upon the value of the water saturation for which the relative permeability to oil becomes zero. The latter is related to the capillary characteristics of the rock and these in turn determine the bound-water content of the rock. In thick oil zones the water saturation is practically equal to the bound-water content and therefore the initial oil saturation is related to the oil saturation after flushing.

Tixier found that the above relation could be approximated by $(S_w)_i^n = S_w$ with $n \simeq 2$, where $(S_w)_i$ and S_w denote respectively the water saturation in the invaded zone and that in the undisturbed formation.

In the preceding sections it was shown, however, that the saturations prevailing in the infiltrated zones depend upon the rate of flow during infiltration and the viscosity ratio of the oil and the water.

To obtain a quantitative estimate of the magnitude of the various factors involved, a series of experiments was carried out in which the effects of each factor were studied, keeping all other factors constant.

In all cases the bound-water content was determined from the capil-

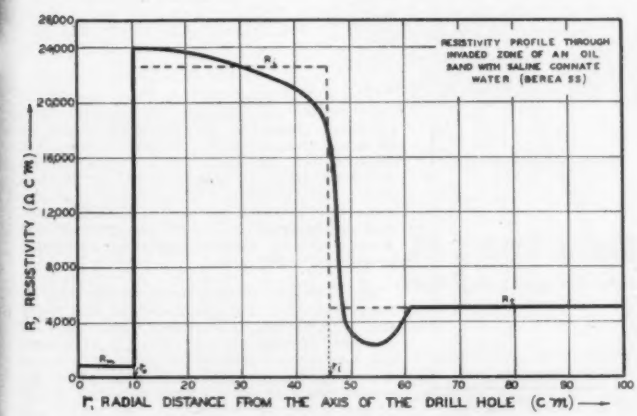
RESISTIVITY PROFILE THROUGH INVADED ZONE OF AN OIL SAND WITH SALINE CONNATE WATER (BEREA SS)
R, RESISTIVITY (Ω CM)
r, RADIAL DISTANCE FROM THE AXIS OF THE DRILL HOLE (CM)

Fig. 17

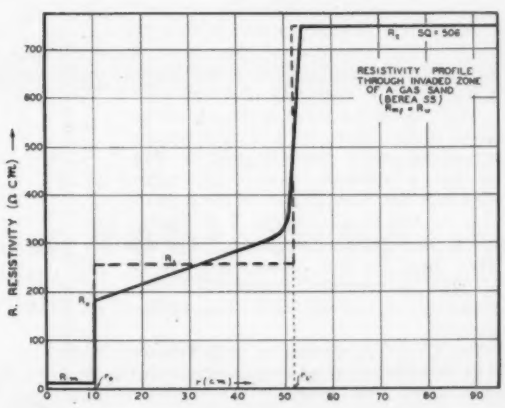

Fig. 18

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lary pressure-saturation relations. To facilitate the interpretation of the measurements, water of low resistivity was used and the infiltrating fluid was always identical to the initially present connate water. Under these conditions the water saturations upon flushing could be determined by measurement of the sample resistivities and the application of Archie's formula.

The main series of experiments was carried out with oil of 30.2° A.P.I. gravity having a viscosity of close to 17 cp. at approximately 70° F.

The pressure gradient during the flushing was kept at approximately 2 psi. per cm.

The average pressure gradients encountered during infiltration of porous horizons around drill holes are mostly smaller, as was shown by Williams.[7]

The relation between $(S_w)_i$ and S_w under the above conditions was investigated for four types of sandstone, namely a Saugus, a Berea, and two types of Pico sandstone.

The relation is represented graphically in Fig. 19, Graph 1. We note that on a log-log scale the relation may be represented by a straight line, which agrees with the findings of Tixier. For the particular conditions in question the relation approaches very closely the graph for the relation $(S_w)_i^2 = S_w$ (Graph 2).

The effect of the pressure gradient prevailing during infiltration upon the invaded zone saturation was found by flushing a sample of Pico sandstone under various pressure gradients and computing the resulting values of $(S_w)_i$ from resistivity measurements. The applied gradients were respectively 0.1, 1, and 22 psi. per inch. The results are shown by points 1, 2, and 3 respectively in Fig. 19.

On the assumption that for any given pressure gradient the relation $(S_w)_i^n = S_w$ holds true, graphs have been drawn through points 1 and 3 to apply respectively to the cases where invasion took place under a gradient of 0.1 and 22 psi. per inch.

To find the effect of the viscosity of the nonwetting phase on the resulting infiltrated zone saturations, $(S_w)_i$ was determined for a Pico sandstone sample, using kerosine (45° A.P.I. gravity, viscosity ≈ 3 cp.).

The following data were obtained: $S_w = 0.31$; $(S_w)_i = 0.73$. The corresponding point is indicated in Fig. 19 by a triangle. Assuming again that the relation $(S_w)_i^n = S_w$ applies also in this case, Graph 3 is drawn to represent the relation between $(S_w)_i$ and S_w for $\mu_o/\mu_w = 3$ (here μ_o and μ_w denote respectively the viscosity of the oil and that of the water).

For Graph 3 we find $n \approx 4$. We see that the variation of n with the value of μ_o/μ_w is quite large.

It is realized that the data presented in Fig. 19 are too few to be relied upon for precise evaluation of the combined effects of viscosity ratios and pressure gradient on the invaded-zone saturations. They merely serve to indicate the general tendencies and the order of magnitude of the variations that may occur.

Taking into account the lowering of oil viscosity with temperature and with the amount of dissolved gas and the lowering of the water viscosity with temperature, as described by Beal,[8] it seems reasonable to make the following approximations:

For average pressure gradients during invasion, use the relation $(S_w)_i^n = S_w$ with $n = 2$ in regions where the surface gravity of the oil is smaller than 30° A.P.I. and use the same relation with $n = 3$ where the surface gravity of the oil is larger than 30° A.P.I.

For extremely large pressure gradients during infiltration, the values of n may be shifted up, and for very small pressure gradients they may be lowered. The magnitude of the shift can be estimated from Graph 1 and the graphs through points 1 and 3 in Fig. 19.

As described in the section on the resistivity profiles through invaded zones of gas sands, the water saturation in such zones varies continuously with the radial distance from the bore face, and we have to use, therefore, the concept of average invaded-zone saturations.

Based on the data obtained in the preceding section for the Berea sandstone, Graph 4 of Fig. 19 has been drawn to represent roughly the relation between the water saturation of the invaded zones and those of the undisturbed formations for gas sands.

Acknowledgments

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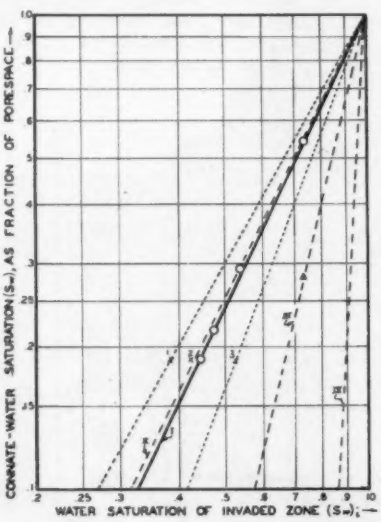

Fig. 19

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BOOKS

CHEMICALS IN THE TEXAS GULF COAST. Published by South Texas National Bank, 213 Main Street, Houston. Gratis upon application of interested persons via letterhead inquiry.

This is an informative multicolor brochure which gives a comprehensive list of the organic chemicals now in production in the Texas Gulf Coast region, tabulated as to product, producer, and plant location. A map of the Gulf Coast petrochemical industry is also presented, together with a discussion of the new chemical frontier represented by the region, and market data for the Gulf Coast area.

STRENGTH OF WROUGHT STEELS AT ELEVATED TEMPERATURES. A report issued under the auspices of the A.S.T.M.-A.S.M.E. joint committee on effect of temperatures on the properties of metals. Prepared by R. F. Miller and J. J. Heger. Published by American Society for Testing Materials, 1916 Race Street, Philadelphia. 109 pp. $3.

This 1950 report gives a great wealth of information and data on the chemical and physical properties of wrought steels at elevated temperatures. Largely a graphical presentation, the data for the report were gathered from a wide variety of sources which are noted in the book. One of the important features is the fact that standard commercial grades of steel are covered, the latest data on tensile, creep, and rupture properties being given.

The report is in two sections, the first 52 pages covering the plain carbon and alloy steels containing molybdenum and up to 3 per cent chromium; the second part covers the ferritic and austenitic steels with more than 5 per cent chromium. The latter includes many of the stainless varieties. Many of the steels for which data are given are covered in A.S.T.M. specifications, the applicable standards being noted.

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UNDERGROUND STORAGE AND MIGRATION OF NATURAL GAS

by F. E. Vandaveer* and J. J. Schmidt†

REFERENCE ENGINEERING SECTION

UNDERGROUND storage of natural gas is being widely used for a number of purposes, but its primary advantages are to meet peak loads, to prepare against pipe-line failures, to permit a good transmission pipeline load factor and to provide for the house-heating load. It is of increasing importance to natural-gas utilities in the northern and western sections of the United States receiving gas from the South. The subject will, no doubt, receive more attention by pipe-line companies, and by manufactured-gas companies in the East which are scheduled to obtain natural gas within the next few years. The largest gas holders of steel construction soon become too small except for short periods of peak demand.

Where local conditions are favorable to the development of underground storage so that natural gas may be used the year around, many technical problems are eliminated. These might be listed as: (1) interchangeability and mixing problems are avoided; (2) procurement of new supplies of fuel during the winter is unnecessary; (3) reforming processes, if used, can be stabilized; (4) if straight natural gas is used, there is no loss of energy (no gum formation, no nitric oxide formed, and no scrubbing needed) as there is in the reforming operation.

Growth of Storage Projects

A few historical facts will indicate that there is a wealth of experience on underground-storage projects. Undoubtedly, a great deal more is known about this subject by operating-company personnel than has been published to date. It is reported by E. G. Dahlgren[1] that the first known successful underground storage of natural gas was in Welland County, Canada, in 1915. A second storage was established in Zoar field near Buffalo in 1916. Three years later Menifee field[2] in Kentucky was started and is still in operation. In 1929 Cities Service established a storage project in Kansas. From that time to 1940, 19 storage fields were started.

In 1940 the Natural Gas Section of the American Gas Association held a symposium on underground storage at its spring meeting at which experiences[3,4,5,6,7,8] of a number of companies were related. These reports were so favorable that from 1940 to May 1949, 54 additional fields[2] have been established. According to Ball[2], 80 fields are now in use and 14 more are being prepared for use. Some 615 billion cubic feet of gas has been stored in them to date and 429 billion cubic feet withdrawn. Eighty-five fields reported[2] have a rated capacity of 497.3 billion cubic feet.

Not Limited to Natural Gas

Storage of gases underground is not limited to natural gas. More than 50 million cubic feet of helium[1] has been stored underground by the U. S. Bureau of Mines in Cliffside field in Texas. Millions of cubic feet of propane-air[9,10] and propane-air natural-gas mixtures have been stored underground by Michigan Gas Storage Co. in Michigan. It is reported[11] that oxygen in this mixture, about 2.3 per cent, almost completely disappeared—only a trace remaining in the exit gas.

Billions of cubic feet of coke-oven[12] gas have been stored underground and recovered without any loss. It was stated that when unpurified coke-oven gas containing hydrogen sulfide was stored there was a gradual decrease of this impurity in storage and a purer gas was withdrawn than was pumped into the wells — also, that there was a slight increase in heating value of gas withdrawn. Nitric oxide is being removed from the coke-oven gas to prevent formation of vapor-phase gum and possible plugging of the wells.

Since coke-oven gas contains carbon dioxide, nitrogen, hydrogen, carbon monoxide, methane, ethane, and unsaturated hydrocarbons the experience of Carnegie-Illinois Steel Corp.[13] at McKeesport, Pa., means that any of those gases can be stored underground as well as other mixtures of these gases, such as may be contained in manufactured fuel gases from water gas, carburated water gas, and oil gases.

Developing Underground Storage Basins

There are several possibilities for developing underground basins for storage of gas. Some of these are being used, others are being studied, whereas others appear to be worthy of consideration. One or more of them could probably be used in any section of the country if the need is worth the effort. Underground storage does not have to be confined to gas or oil fields. A brief resume of five possible structures for underground storage is given below:

1. **Depleted or partially depleted dry gas fields.**—Most of the underground storage pools developed to date have made use of wells in dry-gas fields. This is logical as the wells are already drilled, the performance as to capacity and deliverability is known, and earth structure is known from drilling logs and other records, and the gas tightness of the field up to the original rock pressure has been demonstrated.

2. **Depleted or partially depleted oil**

*Director of laboratories and †general superintendent of production, East Ohio Gas Co., Cleveland. Presented at American Gas Association, 1950 production and chemical conference, New York City.

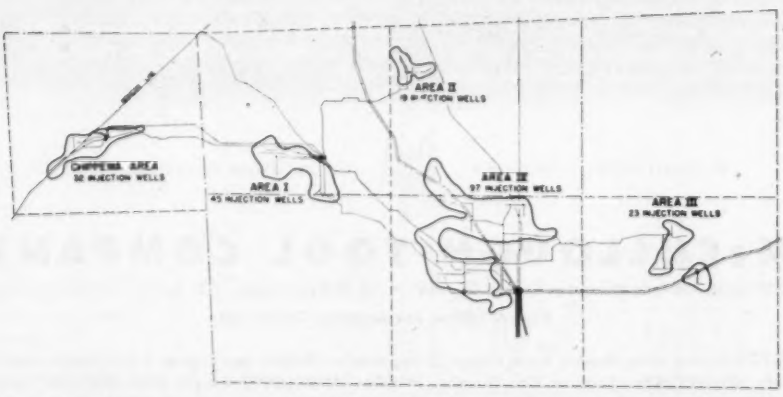
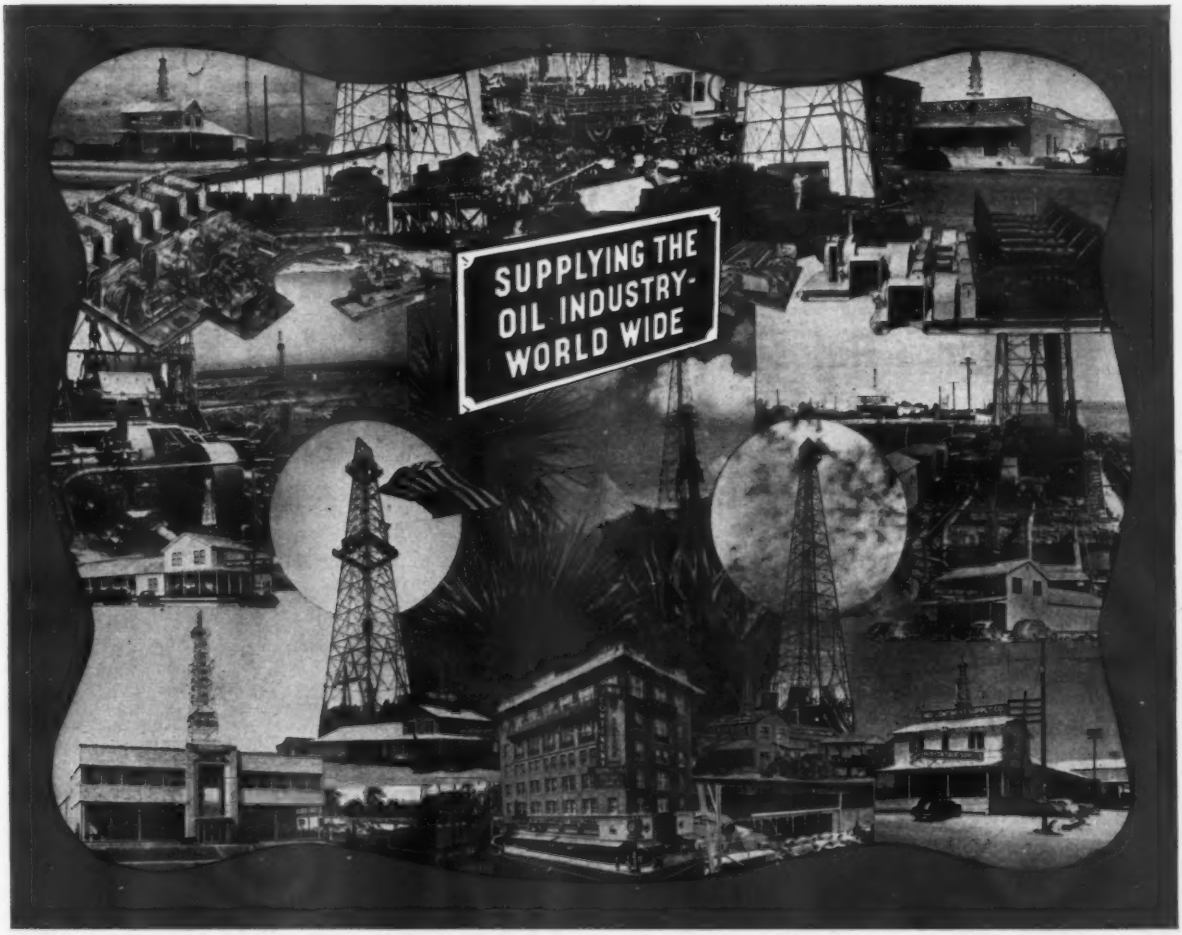


Fig. 1—Underground storage areas of East Ohio Gas Co. Each square equals one township. Total area approximately 24 by 10 miles.



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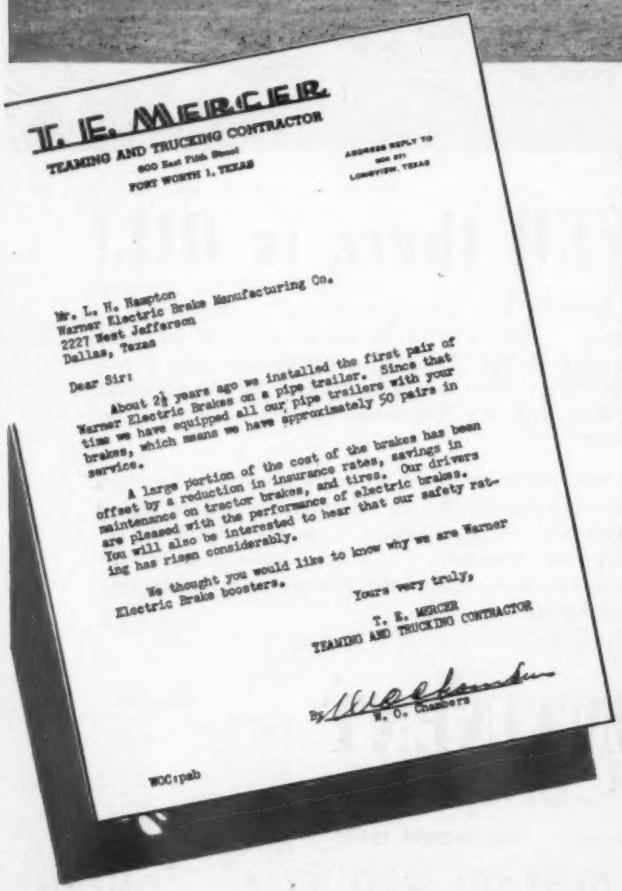

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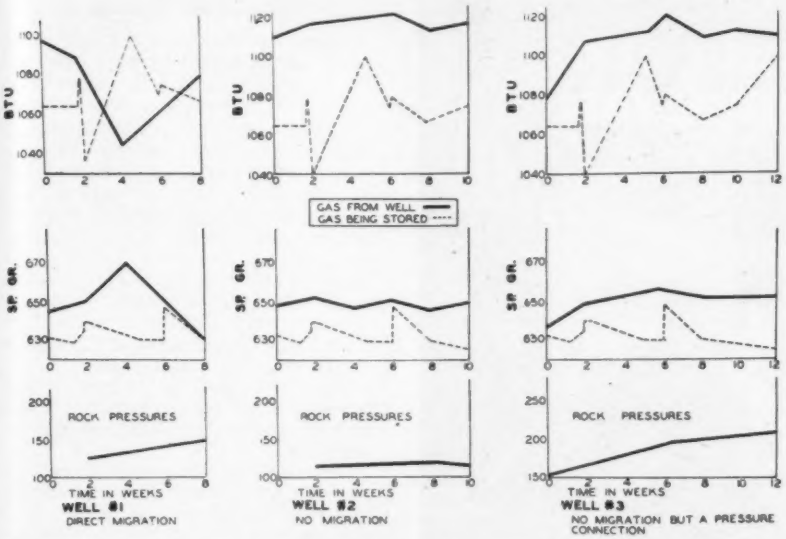

Fig. 2—Typical B.t.u. and specific gravity curves of gas from test wells and those of gas being stored indicating migration, no migration, and a pressure connection.

fields.—One field (Playa Del Rey in California) still producing oil is also being used for gas storage. The reservoir space now in use for gas storage was originally wholly filled with oil. It can be expected that an underground structure which will retain oil under pressure for centuries will retain gas also. The limits of gas volume and pressure would have to be determined and controlled within reason.

3. **Excavations in sandstone, other rock layers, or coal seams.**—A mining operation to create a gas tight holder in a rock layer, or the use of a natural cave, is an intriguing possibility. Sale of the stone or coal removed might be sufficient to retire the cost of the mining operation. A gas-tight holder of any desired size could be created in this manner.

4. **Cavities in salt layers.**—In those states where there are underlying strata of salt, cavities of known size could be made rather easily. The salt could be removed with water by methods now widely used for salt manufacture. This method of creating a underground storage would be relatively inexpensive, particularly if the salt brine were sold or converted to salt. Underlying the entire northeastern third of Ohio[15] and extending into Pennsylvania and New York State there are great layers of salt. And there are known salt deposits in 11 other states. An unknown factor in this method is whether the roof would cave in.

5. **Steel pipe or bottles buried underground.**—Steel pipe[16] or bottles strong enough to hold gas under 2,000 psi. or more buried underground are being used for special purposes. This method is relatively expensive and is limited in capacity. Problems of corrosion of the pipe, compression of the gas to high pressure, removal of all water vapor to avoid hydrate formation and freezing are involved in this method.

Economics of Underground Storage

The primary value of underground storage is that it provides large storage capacity at a minimum cost. The smallest storage project in gas wells reported[3] to date is 700,000,000 cu. ft. and the largest 59,000,000,000 cu. ft. To substantiate these statements a comparison of investment costs of various methods of storing B.t.u.'s is given in Table 1.

A brief review of Table 1 will show how much less expensive underground storage is than any other method of storage or peak-load production listed therein.

Other major economic advantages of underground storage may be enumerated as follows:

1. A larger proportion of the natural gas purchased can be sold for domestic purposes.

2. Less gas need be sold on an interruptible basis or for dump-sale purposes.

3. Peak day loads from 6.0 to 66.3 per cent of the total have been taken from storage.

4. Pipe-line load factors can be maintained closer to 100 per cent and purchase price lowered accordingly.

5. Benefits of storage last for the

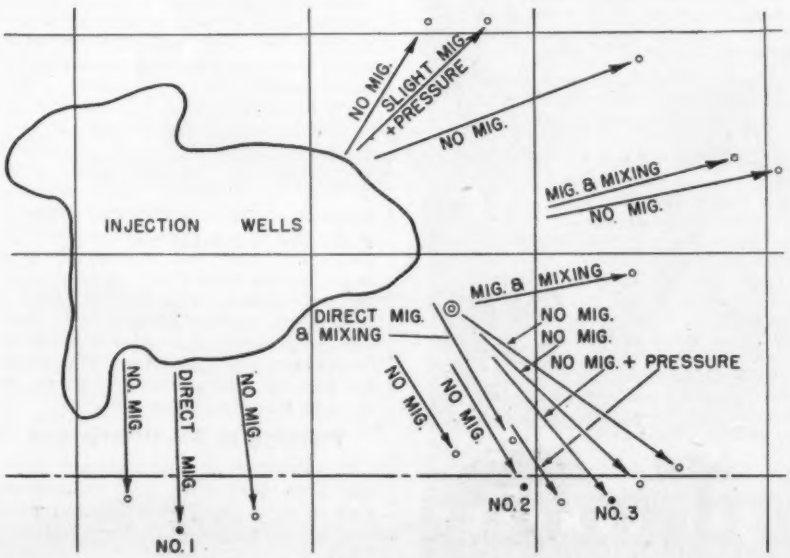

Fig. 3—Storage area No. 1.

TABLE 1
Comparison of Estimated Capital Costs for Various Types of Storage

Type of storage—	Cost per M.c.f. dollars	Reference No.
Sphere (80 psi.)	227.00	15
Steel pipe (2,240 psi.)	207.00	16
Gas holder (low pressure)	156.00	15
Steel pipe (1,560 psi.)	48.00	15
Natural gas in propane	32.00	17
Liquefaction	13.00	15
L.P.—air (1,000 B.t.u.)	7.50	15
Catalytic reforming (1,000 B.t.u.)	3.75	15
Excavations in rock, salt, coal, etc.		No data
Salt cavity storage*	1.42	(Private)
Underground storage (depleted wells)	1.25	18
Underground storage (water sand)	.53	2
Underground storage (depleted wells—13 fields)	.02-.50	2

*Assuming excavation of 1 M.M.c.f. cavity and disposal of salt brine in deep brine strata. Much less if salt is recovered and sold.

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Storage Field Operations

A few details of storage field operations as conducted by East Ohio Gas Co. may serve to clarify some items pertaining to this important subject.

In Fig. 1 the size and relative location of our five storage areas is shown. They are about 50 miles south of Cleveland, between Akron and Canton. The Chippewa area is to the left and the Stark-Summit area consists of the four areas to the right. These areas now have 211 injection wells with numerous other producing wells around the injection wells. Total capacity of these areas at present is about 33 billion cubic feet.

A total of 11,985 hp. of compressors capable of pushing 118 million cubic feet of gas per day into storage is available.

Gas may be both stored and removed from storage every month of the year as illustrated in Table 2 showing operations during 1949. On warm days in the winter gas is stored, and cool days in the summer or pipeline repair may cause the opening of certain wells in the area.

TABLE 2
Operations of Storage and Removal of Gas During 1949

	Input million cu. ft. approx.	Withdrawal million cu. ft. approx.
January	172	728
February	136	822
March	402	1,032
April	751	43
May	1,566	7
June	1,399	9
July	1,421	1
August	2,314	2
September	2,211	3
October	2,109	4
November	612	355
December	41	1,512

Measuring and recording of the volume of gas stored in each area is routine work as well as periodic measurement of rock pressure on each well. Wells are cleaned by watering occasionally when it becomes evident that they are not taking the gas or delivering gas as they should. Due to compression to 1,100 psi., hydrates may be formed and lines to the wells or the well tubing may become plugged if the water-vapor content of the gas is not kept below the dew point. For 1,100 psi. and 40° F. this requires less than 8.5 lb. of water vapor per million cubic feet of gas. Injection of methyl alcohol will prevent hydrate formation or will assist in opening a plugged line. The usual practice to free a line of hydrate is to open it and to let it blow.

Migration of Gas Underground

In selecting an underground storage area geologists and production men rely on the geological and production data available from several years of gas production and drilling experience in the area. They know

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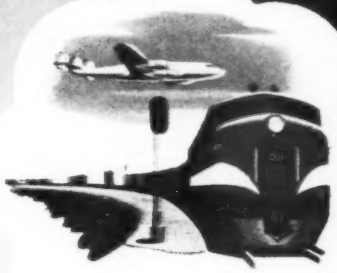

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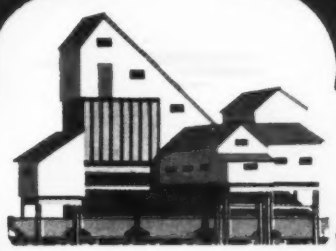

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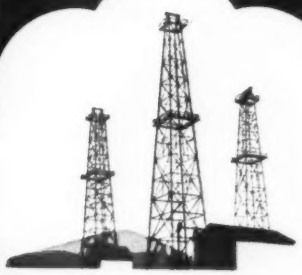

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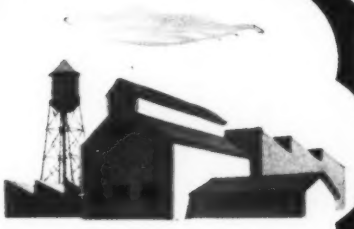

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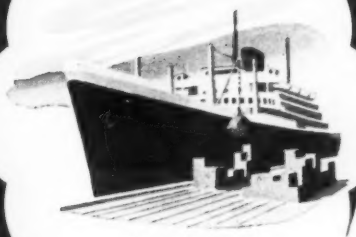

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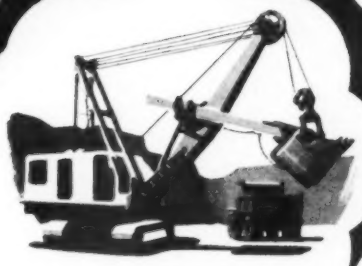

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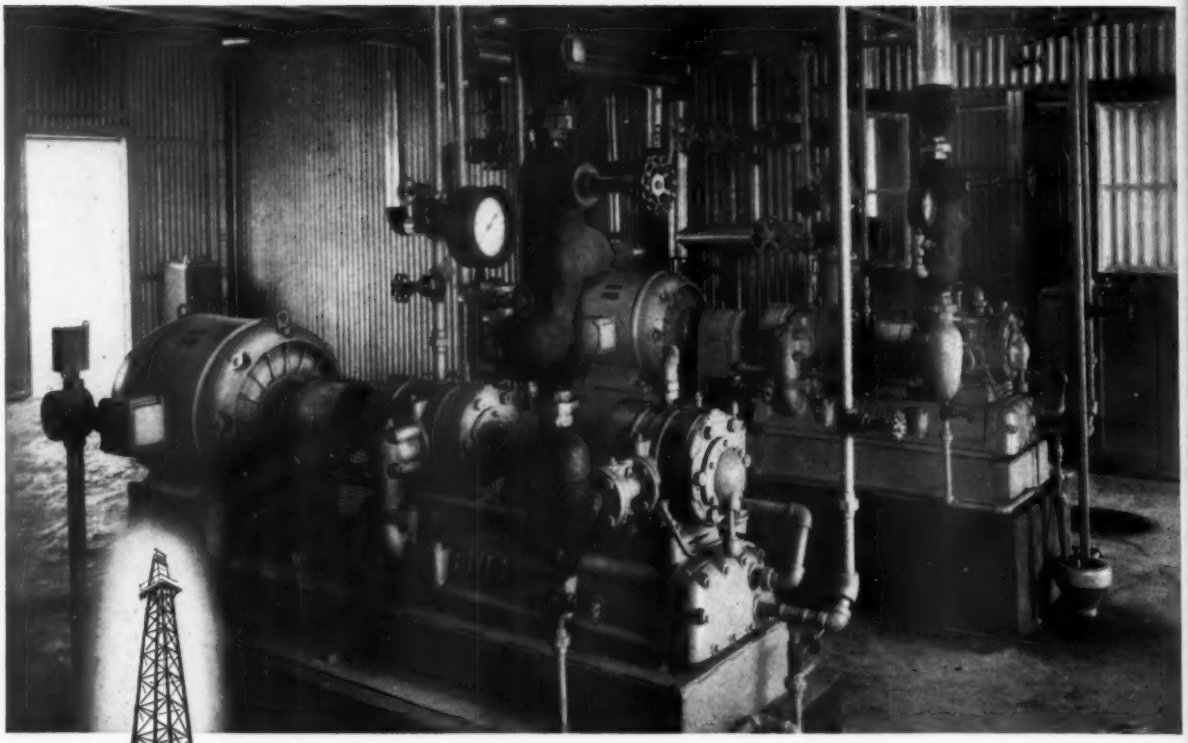

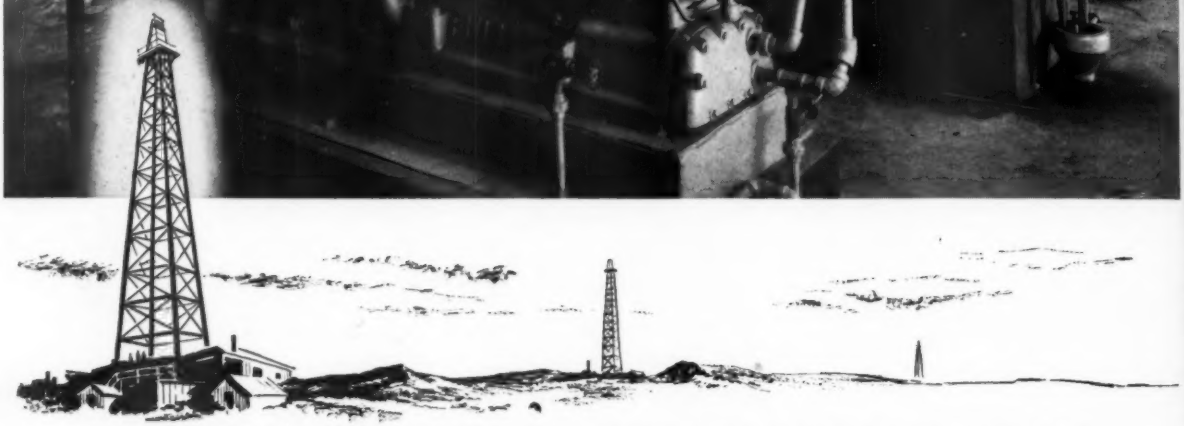

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C-231

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the extent of the field by the location of dry holes, abandoned wells, and small producing wells in the area. They know the amount of gas produced by each well and the rock pressure decrease over a period of time. They know about the cleanliness of the well, and oil infiltration from a history of the well.

When the sand-porosity limit is not fully defined and open necks of unknown length in a sand lense perimeter may be suspected, flow of storage gas out of the necks can be minimized by locating injection wells a mile or so from them. If there are producing wells in the open neck itself, rock pressure of these wells can be watched and gas drained off through them, or other intermediate wells, thus stopping flow of storage gas past them.

Objectives of Tests

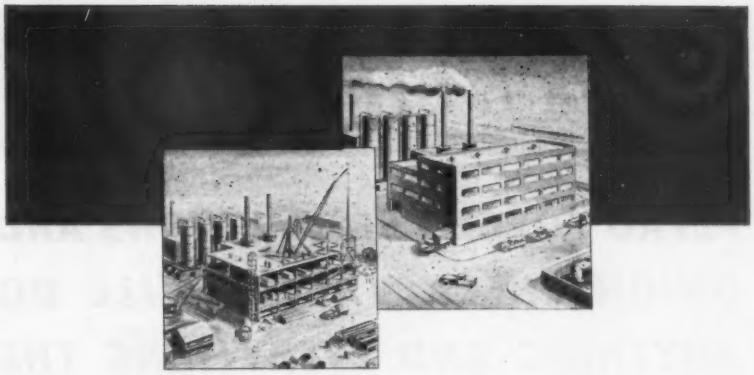
For the past four summers tests have been made in and around our storage areas to determine whether physical flow or migration of storage gas from the injection wells to other producing wells was taking place. The objectives of these tests may be stated as follows:

1. To assist in defining the boundaries of the storage area.
2. To determine whether certain wells were connected through the gas sand structure and how much resistance there was to flow of gas between them.
3. To serve as another guide in planning additional wells for more injection capacity and greater deliverability.
4. To provide further general information on physical characteristics and gas tightness of the storage field.

Previous studies of this nature by others have been based on measurement of rock pressures before and during storage and withdrawal of measured volumes of gas, or addition of helium[19] to the gas being stored and subsequent analysis of gas[20] at various wells in the area for helium content. The rock-pressure method was also used in these studies and provided much useful information. The helium method should be a very satisfactory one but it involves purchase of a large supply of helium and special helium test instruments. And it would necessitate isolation of the storage area during the period of study.

To accomplish our objectives a new method of studying underground movement of gas using common analytical equipment and no change in normal routine of storage of gas was devised. Wells to be tested were shut in for the duration of the tests. As they were normally producing wells which were shut in during the summer months, anyway, there was no interference in gas production or storage operations.

The plan was based on the difference in specific gravity, or heating



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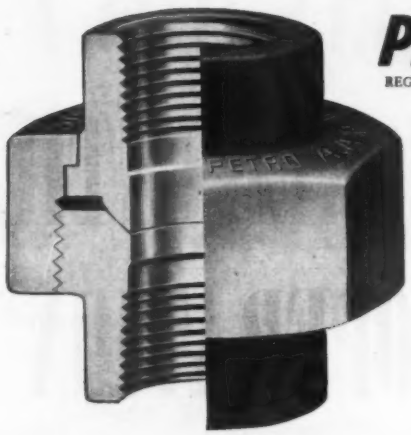

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value, or both of the gas being stored from the gas produced by the wells being tested. Therefore a definite change or variation in specific gravity or B.t.u. or gas samples secured from the test wells over a period of several weeks' time was a direct indication of physical flow of gas from the injection wells.

The general test procedure was to shut in the wells to be tested, secure gas samples, and measure rock pressure on each well at intervals of 1 to 2 weeks and take samples at the same time from the gas being stored in the area. Before taking a gas sample, a pressure gage was attached to the christmas tree and the rock pressure recorded. A valve was then opened to purge dormant gas out of the well tubing. After that, the gas sample was taken in an approved steel tank following a purging of the tank 8-10 times.

The gas samples were brought to the laboratory in Cleveland for analyses for heating value and specific gravity. A Cutler-Hammer recording calorimeter was used for heating-value determinations and an Anubis balance, for determinations of specific gravity.

Separate Well Graphs

As the tests progressed the results were recorded in graph form for each well and for the gas being stored in each area. Separate graphs were kept for each well. B.t.u was plotted against time in weeks and specific gravity against time in weeks on the same graph. Variation in rock pressure in psi. was plotted in the same way. The graph paper used was partially transparent so that if the curves for the gas being stored were held under those of each well a direct comparison of variation in B.t.u. and specific gravity could be made. After 8-10 weeks of testing it was readily possible to determine whether well samples were being affected by migration of storage gas to them.

To illustrate how the data obtained were used to determine whether migration was taking place or not, three examples are shown in Fig. 2. Note in the case of Well No. 1 how the B.t.u. varied similarly to that of the gas being stored and how the specific gravity of the gas varied and finally reached 0.630, the same as the gas being stored—also, a gradual rise in rock pressure of some 20 psi. Direct migration was attributed to this well which was 4,489 ft. from the nearest injection well.

An example of a well receiving no migration was Well No. 2 located 6,157 ft. from an injection well. The B.t.u. and specific gravity remained practically constant and nowhere near the B.t.u. and specific gravity of the storage gas—and rock pressure did not increase. Although Well No. 3 did not receive storage gas, as shown by the totally dissimilar B.t.u. and specific-gravity curves of the well gas

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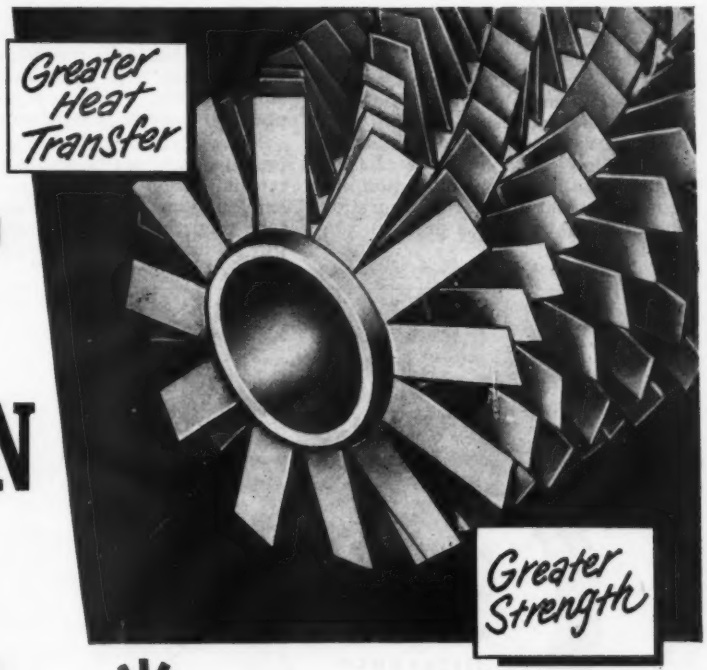

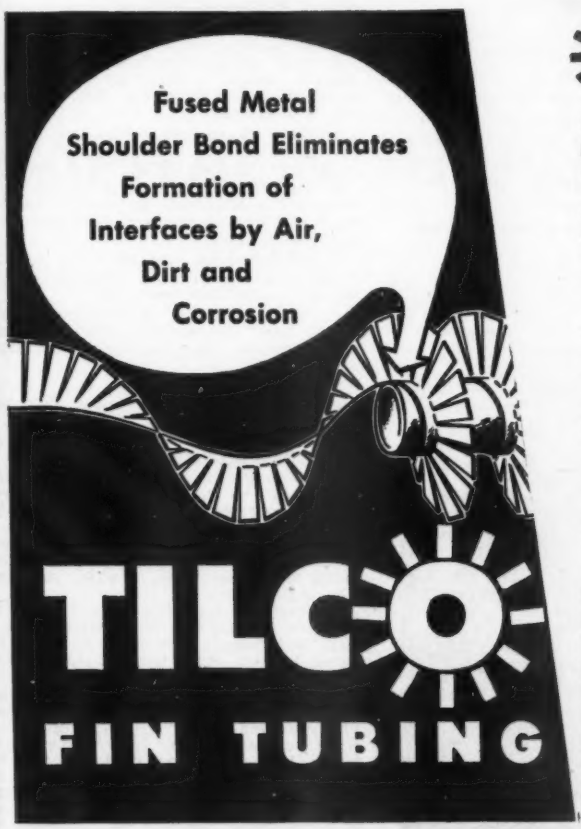

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as compared to the storage gas, the rock pressure increased steadily by some 85 psi. This is evidence of a pressure connection to the injection well pushing the remaining original Ohio gas in the well out and ultimately there will be direct migration.

After data on the individual wells were completed, the conclusions were recorded on a map of each storage area. An example of this is shown in Fig. 3. The injection wells are located within area so marked at the left of Fig. 3. Note the various conclusions of no migration, slight migration, migration and mixing, direct migration, and no migration but a pressure connection.

Four summers of testing of a total of 195 wells, taking some 2,000 gas samples, and analyzing them for heating value and specific gravity have given us confidence in this method of testing for underground migration. It has accomplished the objectives set forth in this paper. Some general observations based on this work may be made which are applicable to our storage areas. They may not be applicable to other storage areas.

1. An appreciable increase in rock pressure may not be indicative of direct migration of storage gas at present, but it undoubtedly indicates future migration will take place when the volume of Ohio gas holding back physical flow of storage gas is decreased.

2. No increase or a very small increase in rock pressure over a period of several months cannot be regarded as absence of migration. Examples of direct migration with no pressure increase have been found.

3. In at least two instances the possibility of large pockets of Ohio gas between the injection well and the test well have been pointed out.

4. The greatest distance for gas to migrate underground observed in our tests to date is 8,360 ft. Other instances of travel of more than 7,000 ft. have been found, but, as a general working basis, a distance of 5,280 ft. will stop the physical flow of gas.

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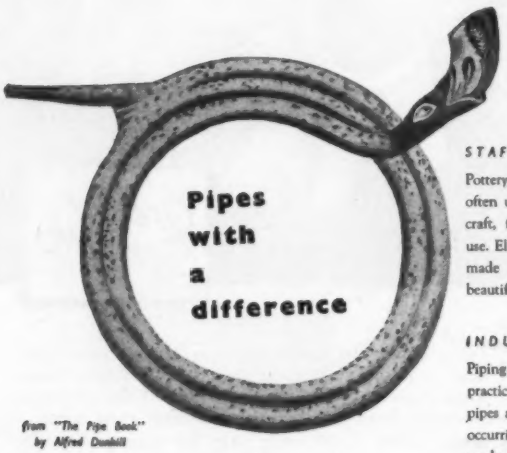

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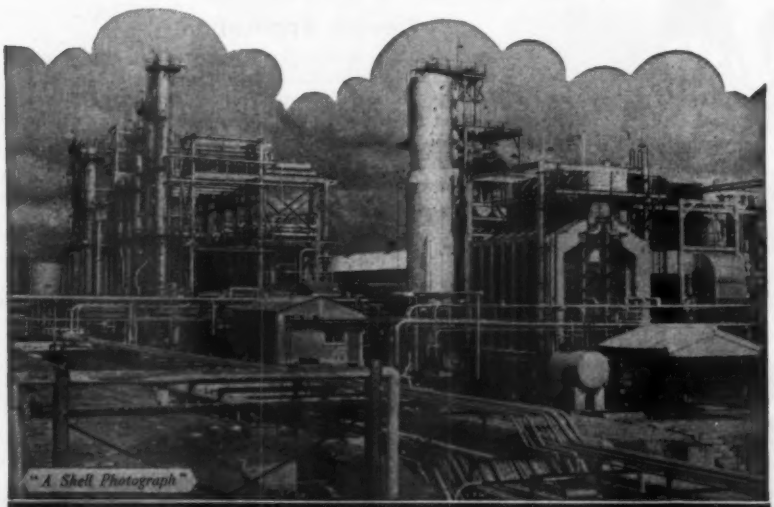

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Federal Reserve Bank Stock	300,000.00	$129,545,973.90
Loans and Discounts	52,660,291.55	
Commodity Loans Secured by Warehouse Receipts	1,608,600.00	54,268,891.55
Bank Premises	4,000,000.00	
Furniture and Fixtures	1.00	4,000,001.00
Interest on Securities and Other Income Earned—Not Collected		244,143.78
Customers' Liability on Letters of Credit		3,394,053.93
TOTAL RESOURCES		$191,453,064.16

LIABILITIES

Common Stock	$5,000,000.00	
Surplus	5,000,000.00	
Undivided Profits	2,311,361.43	
TOTAL CAPITAL ACCOUNT		$ 12,311,361.43
Reserve Accounts		338,440.78
Liability on Letters of Credit		3,394,053.93
DEPOSITS:		
Individual	$131,414,435.83	
Banks	42,059,658.97	
Government	1,935,113.22	
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Some Characteristics of

MASTIC-TYPE PIPE COATINGS

by Gordon N. Scott*

REFERENCE ENGINEERING SECTION

RECENT improvements in pipe-coating materials, especially in their application, and in the handling of the coated pipe at the shop, during transportation, and upon construction in the field, are a direct consequence of the National Bureau of Standard's comprehensive pipe-coating tests which were sponsored both by the American Gas Association[1] and by the American Petroleum Institute.[2] These large-scale experiments have, very evidently, amply served their purpose. New lines of investigation now seem in order to test the service performance of these modern coatings.

Further costly programs like those of the National Bureau of Standards would hardly be expected to yield much new design information and therefore more such tests seem unwarranted. On the other hand, the United States, traversed as it is with myriad coated pipe lines, is a virtual laboratory open to those who would work in it. There could be undertaken no mutual or cooperative coating tests of greater value to the pipeline industry than an exhaustive survey of coatings in service conducted in this vast laboratory under the auspices of an impartial agency. It seems assured that the National Association of Corrosion Engineers will make such an investigation.

The principal purpose here is to outline the use and to describe the results of certain highly informative tests which can be made upon coatings in service. Discussion is confined to application of these tests to a single type of coating.

Methods of Examination

About 15 years ago the author became interested in techniques for the examination of pipe coatings on actual operating pipe lines. While coatings of many types have since been examined, present interest is limited to mastic-type coatings because these coatings are unique in that they can be made to afford complete pipe protection for an indeterminate period of time without the aid of supplementary electrical protection.

Two methods or tools employed in the study and some of the results obtained have been recently described[3] in some detail. These methods are:

1. Examination of the coated line by the Pearson discontinuity locator,[4] sometimes referred to as a "coating discontinuity survey."

2. Measurement of the average conductance of the coating over a fixed length of pipe line.

The former method aims, as its name implies, to locate discontinuities in the coating on buried pipe lines. The latter method serves numerically to characterize the coating. It is thus of especial value in following the behavior of the coating with time.

The advantages of a coating discontinuity survey over a laid coating of the mastic-type are almost self-evident; they are:

1. Frequency of discontinuities is usually so low that between 5 and 15 miles of right-of-way can be traversed in a day. The cost of the survey is, therefore, negligibly small.

2. Periodic surveys at 2 or 3-year intervals insure that the coating is always continuous.

Some disadvantages include:

1. Functioning of the apparatus depends upon contact of the soil or soil moisture with the pipe metal through any existing holidays or imperfections. In relatively dry western soils the necessary contact in some instances may be delayed for 2 years or more.

2. Functioning also depends upon good electrical contact between the operators' cleats and the soil. Good contact often cannot be secured in dry seasons especially over plowed ground, matted vegetation, and graveled roads. Suitable contact cannot be made over concrete highways or oiled road surfaces. The traverse is, therefore, inapplicable under these conditions and also in city streets.

Conductance Measurements

Measurements of coating conductance are very simply made. The procedure, however, depends upon conditions pertaining to the particular structure of interest and also upon the objectives of the test. For example, if the coated pipe line is grounded at flooded gate boxes, cable suspensions and the like (see Huddleston[5]) one procedure would be followed while another would be used if the line were everywhere insulated from ground. The results of the tests can be simply stated in terms of "average conductance of coating per square foot of pipe surface." However, this simple number by itself is inadequate fully to characterize the coating since soil resistivity is inherently involved. Accordingly, figures on the coating conductance should be accompanied by information on soil conditions—especially the soil resistivity.

The theory behind the measurements is well known. It has been employed in the design of cathodic protection and a number of instances of its use have appeared in the literature. Strangely, however, no general use of the theory has been made solely for the purpose of evaluating or comparing coatings or of studying the performance of a coating with respect to time.

The author is not familiar with any carefully made field measurements over substantial lengths of coating, tracing in time sequence the behavior of a coating, and yet the measurement provides the simplest, most direct, and powerful tool for such studies. We have, in short, an as yet unexploited trouble-shooting tool. The theory affords a means of quantitatively describing a coating so that opinion, a current "criterion," may be abandoned.

Discussion

Cases of coating discontinuity surveys cited in the earlier report[3] were made during the period from 1944 to 1948. They covered coatings ranging in age from 0.6 to 5.50 years on pipe lines ranging from 6⅝ to 18 in. in diameter in stretches extending from 3½ to 100 miles in length. **The total area of coated pipe covered in the report was almost exactly 3½ million square feet. Over this vast area of coating a total of only 75 discontinuities were found.** About 67 per cent of them were attributed to construction errors — abrasions or discontinuities which could easily have been avoided

TABLE 1—DATA ON COATING DISCONTINUITY SURVEYS

Case No.	Inspected	Age, yrs.	Size, in.	Mileage	Total discontinuities
VIa	March 1950	6.0	6⅝	9.67	12
IX	March 1950	2.0	8⅝	24.63	1

*Pipe line technologist, 555 South Flower Street, Los Angeles 17, Calif. Presented at Transmission Conference, Pacific Coast Gas Association, Santa Maria, Calif.

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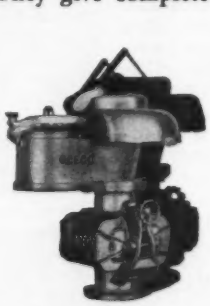

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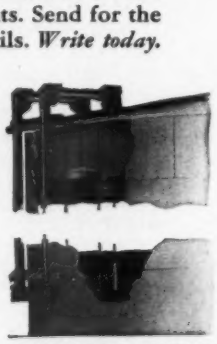

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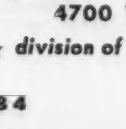

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by more adequate control or inspection during construction.

Several years ago the growing realization that most of the discontinuities in the mastic-type coatings could have been prevented led one pipe-line operator to write a "coating discontinuity clause" into the construction contract, a sample of which is the following:

"All asphalt-mastic sections of the completed line will be surveyed by **COMPANY** with an electronic holiday detector of the "Pearson" type within 1 year after backfilling. If any flaws are detected by this survey, **CONTRACTOR**, at his option, shall either uncover and repair the coating at these points, or shall reimburse **COMPANY** for the cost of such work."

It would quite evidently be hazardous to attempt any such clause for any other type of commercial coating than the mastics.

More recent clauses specify 2 years after backfilling so that the backfill would be subjected to two rainy seasons and thus be better settled and more likely in contact with exposed pipe. The traverse is, accordingly, more reliable.

Since the reference report was written, two new coating discontinuity traverses have been run. The first was a retraverse of 9.67 miles of 6⅝ asphalt-mastic coated pipe laid in November 1944 (Case VI of reference report). The second was a survey over 25 miles of an 8⅝-in. line laid under the discontinuity clause.

The retraverse was run for essentially three reasons:

1. The original traverse was deficient in that it was run too soon after laying (1.10 years) and too late in the spring for the operators to secure good electrical contact between their shoe cleats and the soil.

2. Since the coating was not laid under the discontinuity clause it was desired to compare performance with a similar neighboring and more recent asphalt-mastic coated line which was constructed under the discontinuity clause.

3. As an experiment to determine (1) if cathodic protection would assist through electrokinetic effects in establishing contact between earth and pipe and (2) if mild cathodic protection had any observable detrimental effect on the coating. (About 60 ma. was applied through a galvanic anode to the midpoint of the coated line in December 1946).

The results of these traverses appear in Table 1.

The retraverse (Case VIa) shows conclusively that under conditions of low rainfall contact between soil and pipe is not established after only one rainy season since a number of discontinuities in addition to the one found in 1945 were located. Of these 12 discontinuities 3 were of recent origin, 9 were construction errors, and 1 was defective plant coating, which, under the modern foot-by-foot electri-

cal inspection at the plant immediately after application, would likely have been corrected before shipment. The one discontinuity in Case IX occurred after the coating was laid. If the traverse is considered reliable the effectiveness of the coating discontinuity clause is apparent.

That for arid soils complete reliance cannot be placed upon the coating discontinuity survey has also been shown in another instance by the subsequent development of a leak on a traversed section of line. Accordingly, the simple, inexpensive conductance measurement as a supplement to the coating discontinuity survey is strongly to be recommended. This test, if made at sufficiently close time intervals, would probably insure detection of any breaks in the coating before leaks in the pipe develop.

It could not be determined by inspection of the exposed coatings of the retraversed line if the mild cathodic protection had been helpful in establishing contact between soil and pipe, but it appeared that no deterioration of the coating had occurred as a consequence of the applied current. The question is yet open, however, and the experiment is being continued.

Three of the discontinuities reported under Case VIa as well as the one discovered in Case IX are of recent origen. These were caused in all four instances by trenching machines during pipe-line reconditioning operations for ditching for irrigation lines. In one instance a small circular hole had been dug in the mastic coating for the purpose, it appears, of testing the mastic-coated line with respect to that of the crossing pipe line which was under cathodic protection.

As a consequence of the retraverse an interesting suggestion has been made. In cases where pipe lines are patrolled by air, construction activity of any sort in the vicinity of the owner's pipe line and especially trenching operations should be reported to the company by the pilot. In such cases disruption of the coating might be forestalled but at least the possibility of damage to the coating would be known.

Conductance measurements can be made at negligible cost, especially if the section of coated line of interest is set apart by insulating flanges.

In order that the measurements have meaning, however, some reference scale is needed. Such a reference, which follows, is an empirical relation between conductance and the probability of finding corrosion on the pipe which applied to the National Bureau of Standards' Pipe Coating Tests.

"... it was shown that, if the conductance was less than 10 micromhos per square foot, the coating was likely giving perfect protection (pipe uncorroded); while, if greater than 40 micromhos per square foot, the coating was faulty (pipe corroded); and,

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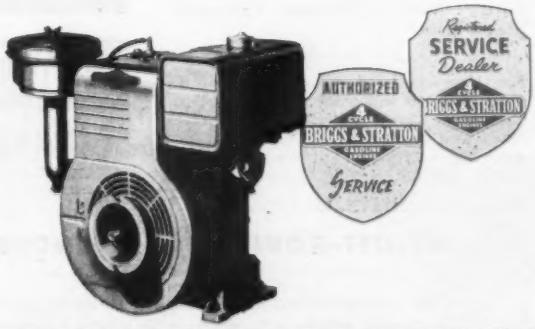

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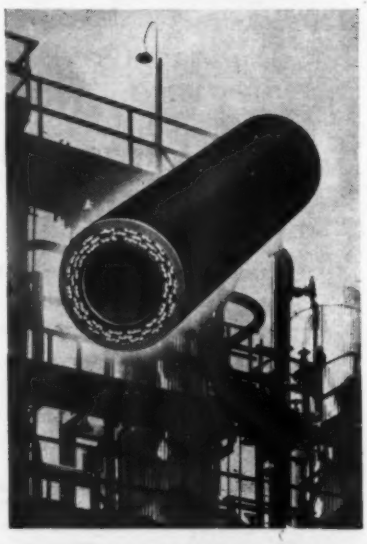

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if lying between 10 and 40, the coating was possibly faulty (the pipe mildly corroded, if at all)."

It has not been shown that this reference may be used to predict presence of holidays in the coating on extensive pipe lines. But it would be reasonably safe to assume that a conductance of less than 1 micromho per square foot indicates a continuous coating. Usually the conductance of the mastic-type coatings is less than this value. In two instances reported in the author's recent paper it was at once apparent from a single test of an insulating flange that something was amiss. Subsequent tests disclosed shorted insulating flanges in each case 20 to 28 miles respectively away from the point of test.

Once the preliminary tests have been made, calculations employing the known constants of the pipe line (its length and electrical resistance) show at once in conjunction with the mathematical development what further tests should be made and whether a coating discontinuity survey should be run.

Conclusions

Until further experience is gained there seems little need to modify the tentative conclusions reached in the earlier report[3] which are repeated below. However, two new tentative conclusions have been added.

1. The coatings are performing satisfactorily even under wet and highly corrosive environments.
2. The low conductance of the many coatings tested indicates no marked absorption of moisture by asphalt-mastic coating; and the effect, if any, exhibits no bearing on corrosion.
3. By far the largest proportion of holidays found in the coatings could have been avoided by inspection, and are thus classed as construction errors.
4. With proper construction specifications, by complete inspection programs, and by using suitable methods of testing laid coating, a perfectly continuous coating may be obtained.
5. The need for cathodic protection as a supplementary safeguard against corrosion is not indicated, but can be applied on an exceedingly small scale.
6. Aside from removal of large rocks and soil clods, there appears no need for elaborate trench dressing.
7. Coating discontinuity surveys should be conducted at 3 to 5-year intervals during the life of the line.
8. Simple conductance tests of the coating should be made at 3 to 6-month intervals.

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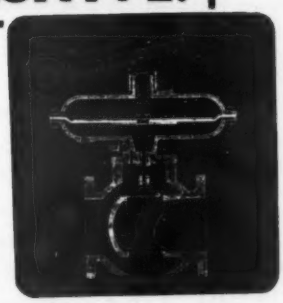

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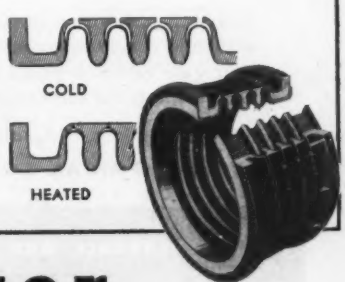

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IN CALIFORNIA DRILLING OPERATIONS

Causes and suggestions for prevention

by A. J. Horn

SIXTY-SIX well blowouts involving 30 companies and operators have occurred in California drilling operations during the 10-year period from 1940 to 1949. During this decade, approximately 18,000 oil and gas wells were drilled. Including all exploratory operations and limiting the development operations to those fields where blowouts were actually experienced, these 66 well blowouts took place during the drilling of approximately 7,550 wells. This amounts to 0.8 per cent. Of the 66 blowouts, 34 occurred in drilling development wells, 29 occurred while drilling exploratory wells, and 3 were unspecified as to time or location.

In development operations in those fields experiencing blowouts, the percentage of well blowouts to wells drilled was 0.6 per cent for the 10-year period from 1940 to 1949. During 1944, a peak of 10 blowouts occurred, amounting to 1.4 per cent of the development wells drilled. Since then, however, the number and percentage of blowouts in development drilling has been steadily increasing.

In exploratory operations, the percentage of well blowouts to wells drilled was 1.4 per cent for the 10-year period, or about three times the percentage in development drilling. The peak of almost 5 per cent occurred in 1941, although high percentages also occurred in 1944 and 1947. The number and percentage of blowouts in exploratory operations also has been decreasing during the 10-year period, but the trend since 1944 is not as regular as for development wells.

Well histories of 55 of the above-mentioned cases were sufficiently complete to permit a study of drilling practices preceding the well blowouts. These have been analyzed from the standpoint of determining causes of such blowouts and their relative significance. Based on this investigation, some precautions are suggested for preventing the uncontrolled flow of formation fluid which results in well blowouts.

Investigation of the Causes of Well Blowouts

Control of formation fluid pressure. It is obvious that the pressure exerted by the drilling-fluid column must be greater than the pressure of the formation fluid at any depth in order to prevent the formation fluid from flowing into the bore hole and to the surface. The pressure of the drilling-fluid column at any depth is usually considered to depend solely on the height of the column at that depth and on the density of the drilling fluid. The basic cause of well blowouts, therefore, is an insufficient static head in the drilling-fluid column adequately to exceed the formation pressure.

REFERENCE ENGINEERING SECTION

The maintenance of control over the formation pressure may be divided into the following:

1. **Primary control**—a function of the drilling fluid, as determined by the fluid density and the column height.

2. **Secondary control**—a function of surface blowout-control equipment for shutting in the well.

The installation of surface equipment with an adequate well-casing program is of great value, but it can only be used to control a well blowout after failure of primary control by the drilling fluid.

Formation fluid pressure considera-

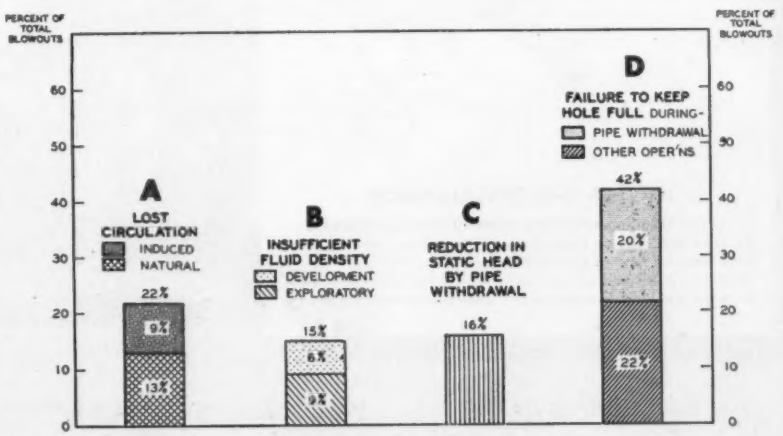

Fig. 1—Causes of well blowouts through failure of primary control.

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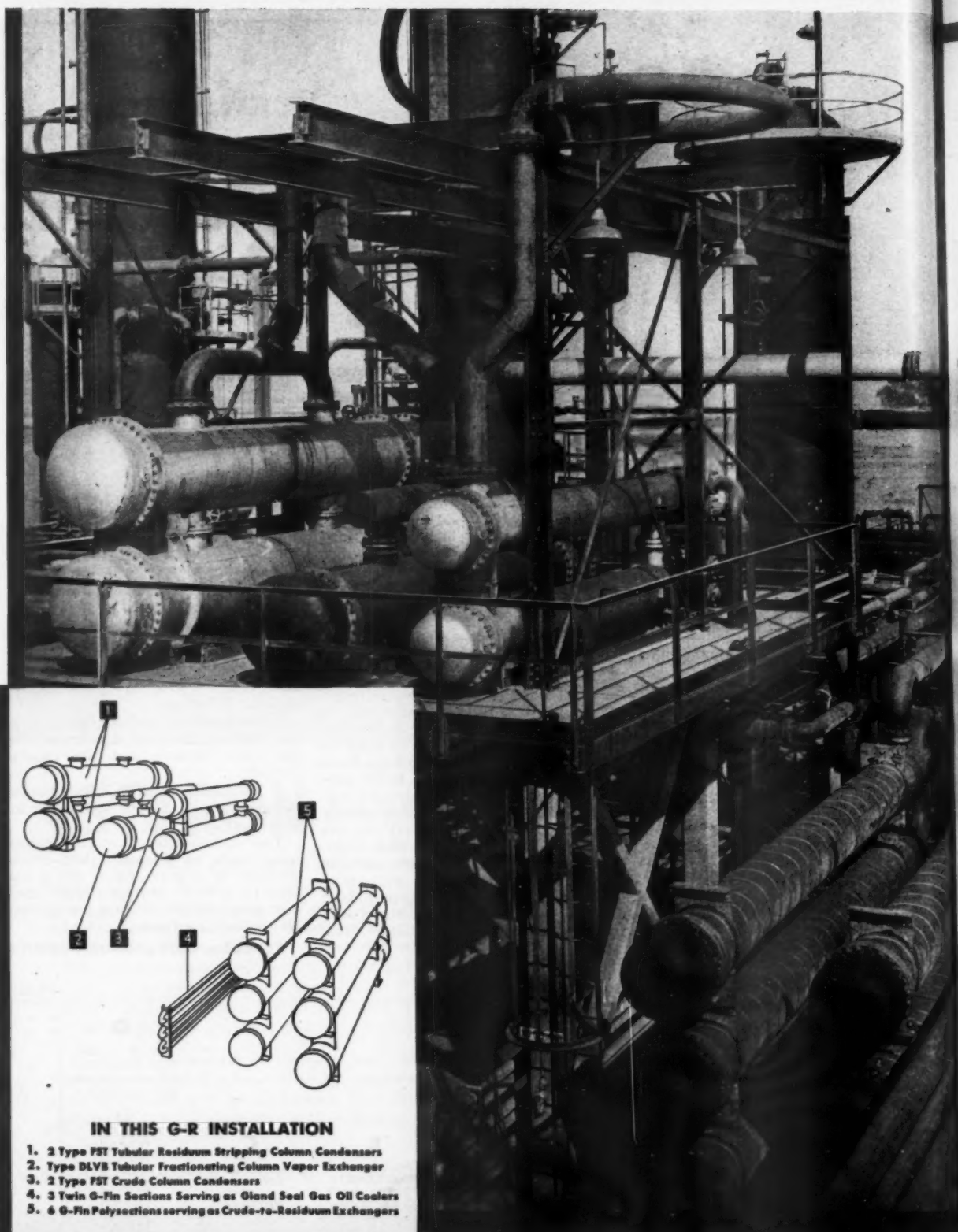

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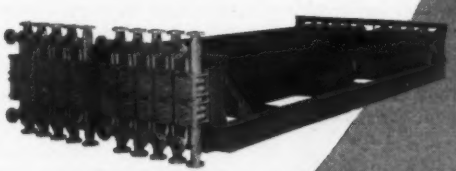

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A. J. Horn is petroleum engineer with Standard Oil Co. of California. He graduated from Stanford University in 1939 and was employed by Standard Oil Co. of California initially as chemist in producing department laboratory at Taft and later as a drilling-fluid engineer and field-development engineer in the Taft, Kettleman Hills, and Coalinga areas. He served in the U. S. Navy from 1942-1946, then returned to Standard of California as petroleum engineer at La Habra. In 1948 he was transferred to the San Francisco office. Paper given at spring meeting, A.P.I. Division of Production, Los Angeles.

TABLE 1—CLASSIFICATION OF WELLS FOR INSTALLATION OF BLOWOUT CONTROL EQUIPMENT

Class	Formation pressure characteristics	Type of blowout control equipment
1.	Settled pumping field where no zones are to be penetrated which have sufficient pressure to cause a blowout, even in the case of lost circulation.	None, however, a complete shutoff gate is recommended in all cases.
2.	Settled producing fields where sufficient pressure may exist in the productive zones to cause a blowout, particularly under lost-circulation conditions; or fields where a gas zone may be exposed above the objective; or field where under low pressure flowing production is obtained.	Rams to close around drill pipe and complete shutoff rams—hand or power operated. (If two sizes of drill pipe are used, a bag packer should also be installed.)
3.	High-pressure flowing production fields; also all dry gas wells, exploratory wells, and wells drilled through formations on which information is incomplete.	Flexible packer to close around drill pipe, kelly, or irregular-shaped equipment; a control gate with complete shutoff rams and a second control gate with drill-pipe rams. (Equipment provided for power and emergency operation.)

tions.—It is generally agreed that original formation fluid pressures of productive zones in California are normally equivalent to the static head of a salt-water column to the surface or to the height of the water table in the formation outcrop. This depth-pressure relationship results in a normal pressure gradient of approximately 0.44 psi. per foot. From published data the pressure gradients in California fields are found to range usually from 0.418 to 0.524 psi. per foot for oil reservoirs and from 0.405 to 0.486 psi. per foot for gas reservoirs.

In several areas, gas or salt-water sands have been encountered with pressure gradients considerably in excess of the hydrostatic gradient and higher than those of overlying and underlying oil and gas zones. Based on the drilling-fluid density necessary to prevent extraneous fluid entry, two wells in the Sacramento Valley penetrated permeable Cretaceous sandstones having pressure gradients approximately equivalent to the geostatic (or overburden) gradient of 1.0 psi. per foot. For a summary of possible reasons for abnormal formation pressures, reference is made to a recent study by E. V. Watts[1] pertaining to Ventura Avenue field.

It may be concluded from the above data that a drilling fluid density of 76 lb. per cubic foot should be sufficient to balance the original formation pressure in most of the oil or gas zones in California fields. On the other hand, the presence of abnormally high formation pressures in permeable intervals above the objective zone has required drilling fluid densities of 87 to 126 lb. per cubic foot (and occasionally higher) to balance the formation pressure safely.

1. Loss of Primary Control Over Formation Pressure

The blowouts investigated in this study were found to have been caused by one or a combination of the following factors in the loss of primary control:

A. Reduction in fluid level by lost circulation.

B. Insufficient drilling fluid density.

C. Reduction in static pressure by pipe withdrawal.

D. Failure to keep hole full of fluid.

The importance of these factors in well blowouts was determined by classifying each blowout according to principal cause and contributing cause, depending on the estimated proportion of pressure reduction obtained in each case. The percentage of well blowouts attributable to each of the above factors in primary control failure is summarized in Fig. 1.

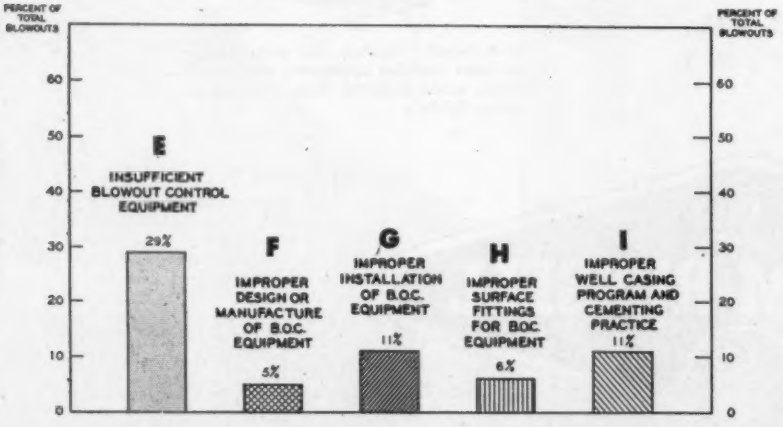


Fig. 2—Causes of well blowouts through failure of secondary control.

A. Reduction in Fluid Level by Lost Circulation

A loss of circulation to the surface will cause a reduction in height of the mud column and, therefore, a reduction in static head at the blowout zone. This factor is particularly dangerous in causing well blowouts because its occurrence is not predictable and is quite often rapid. Twelve of the blowouts, or 22 per cent, resulted from a loss of fluid into exposed formations.

This cause of primary control failure may be further resolved into:

1. Natural lost circulation; and

2. Induced lost circulation by (a) running-in pressure, (b) excessive fluid density, (c) type of fluid.

1. **Natural lost circulation** is the quality of the formations which results in loss of normal density drilling fluid into fissures, cavities, highly permeable sands and gravel beds, and semidepleted productive zones. This loss may occur at a depth above or below the blowout zone during drilling or after a necessary increase in drilling-fluid density has been made to maintain control over the formation pressure in the potential blowout zone. Seven of the blowouts, or 13 per cent, occurred during actual drilling as a result of this lost circulation.

2. **Induced lost circulation** occurs when a pressure considerably in excess of that required to prevent the inflow of formation fluid is imposed on the walls of the hole and causes loss of circulating fluid with a drop in fluid level. The increase in pressure which induces this type of lost circulation may result from the following:

(a) **Running-in pressure** is defined as the increase in pressure throughout the column of drilling fluid as a result of running in drill pipe, casing, or various drilling tools. The proof of the existence and an approxima-

tion of the magnitude of running-in pressures may be obtained by reviewing a study by G. E. Cannon[3] on the relationship of drilling-fluid gel strength to pressure reduction by the withdrawal of drill pipe. In this paper, the effect of gel strength was determined "by withdrawing 90 ft. of drill pipe and lowering it immediately to its original position . . ." A review of Cannon's Fig. 3 indicates a pressure increase over the static pressure during the return of the pipe to its original position in Tests A, B, C, and D.

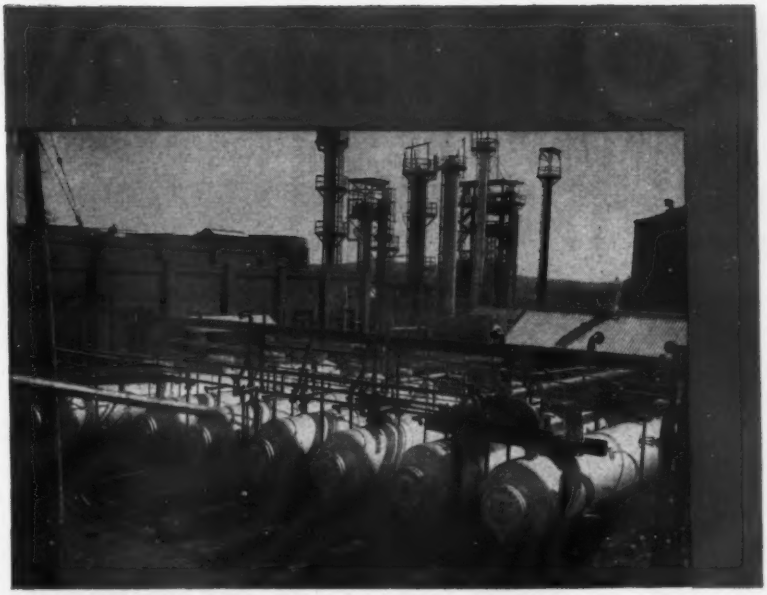
Since field experimental evidence has been obtained by Cannon on the relationship of gel strength to pressure drop during the withdrawal of pipe, it seems reasonable to presume that there is a corresponding pressure increase during the running of pipe. Two of the blowouts, or 4 per cent, resulted from a drop in fluid level from lost circulation caused by this running-in pressure.

(b) **Excessive fluid density** is used frequently in exploratory drilling in anticipation of encountering high pressure zones or after observing some contamination of the circulating fluid by gas, oil, or salt-water entry. Infrequently, an interval above or below the blowout zone will weaken under the excessive bore-hole pressure, causing a loss of head and increasing the danger of a blowout. Cement slurry in casing-cementing operations has often induced loss of fluid because of its high density (110-120 lb. per cubic foot) during displacement of lower-density mud. This fluid loss may occur in formations which have not shown a tendency toward this trouble during the drilling of the hole. The cause of three of the blowouts, or 5 per cent, can be attributed directly to this phase of cementing operations.

(c) **Type of fluid** plays an interesting part in the loss of fluid from the bore hole. There are three blowouts in which this factor contributed to the static pressure decreases resulting in the blowouts. In semidepleted oil zones with associated fingers of lenticular or locally fault-sealed gas sands, a low-density drilling fluid may be used satisfactorily for drilling into the zone and controlling the formation pressure of the previously undepleted gas sands. Upon completion, however, the circulating fluid is often changed to oil or chemically treated water for wall scraping or for perforation washing. These fluids do not form satisfactory wall cakes, and during static periods they tend to flow into the permeable low-pressure portions of the exposed zone. The resulting decrease in static head by this drop in fluid level may contribute significantly to the cause of a blowout from previously undrained sands within the productive zone.

B. Insufficient Drilling-Fluid Density

The most obvious cause of the loss



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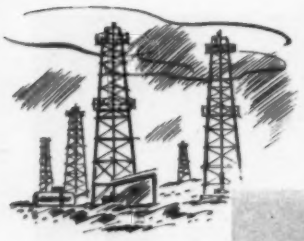

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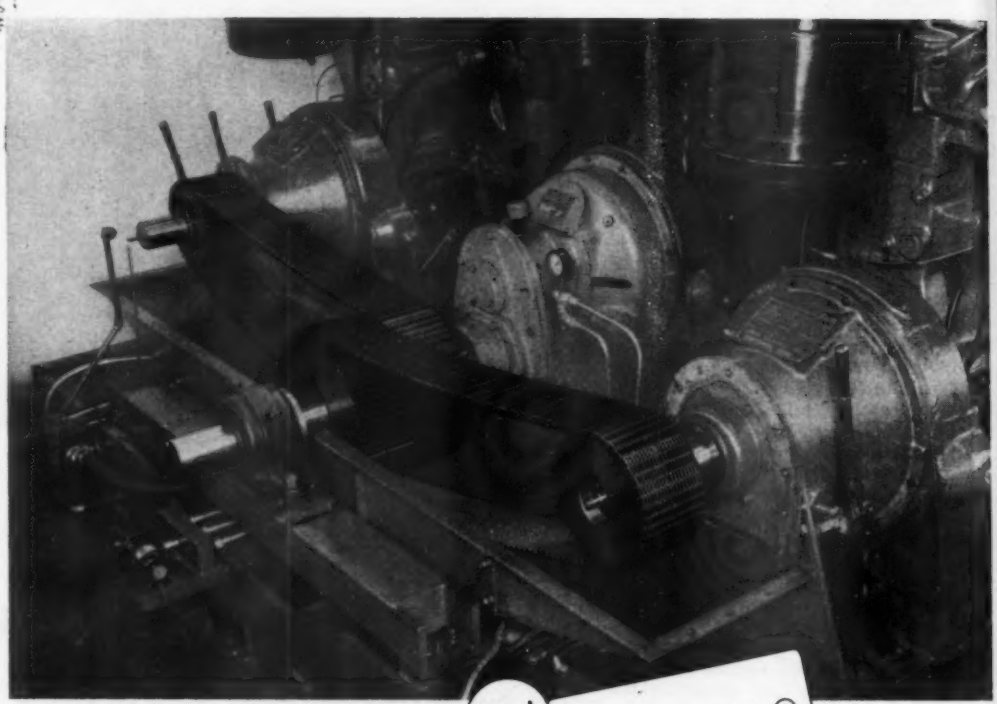

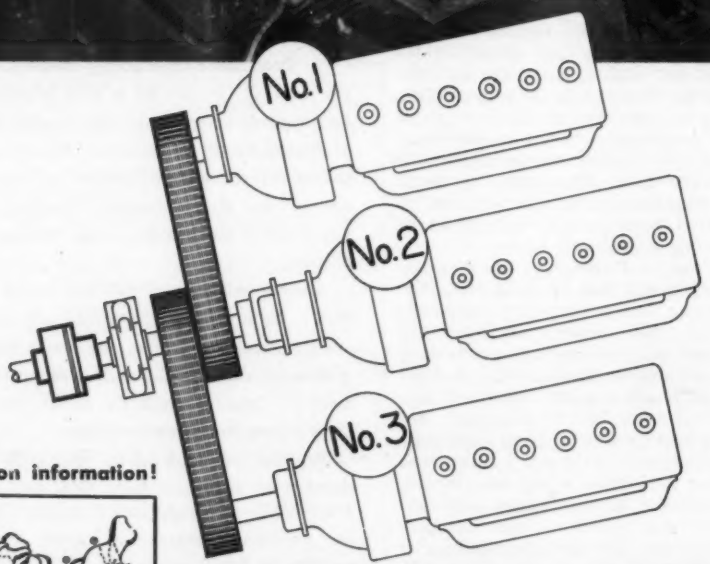

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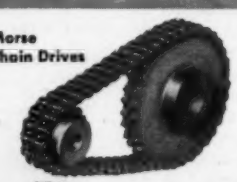

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of primary control over formation pressure is insufficient drilling-fluid density. This review of well blowouts reveals that this factor was the principal cause for eight blowouts, or about 15 per cent of those studied. It was not considered to be a contributing cause in any of the blowouts, since it is easily seen that a sufficiently high drilling-fluid density would permit considerable latitude in other causes of the loss of primary control without a blowout occurring.

This factor has been further divided into the following:

1. Development operations.
2. Exploratory operations.

1. **In development operations,** information should be available from previous drilling in the field to provide a reasonable basis for estimating the formation pressure of the various permeable sands to be penetrated. When insufficient density of the drilling fluid is the principal cause of a blowout under these conditions, it is the result of inadequate consideration of formation characteristics prior to drilling and during completion operations.

There was only one blowout from this cause in development wells during actual drilling. However, it was possible in several cases that some gas cutting of the mud had taken place during drilling which may have contributed to lowering the effective head by a reduction in fluid density. This reduction, in turn, may have contributed to well blowouts resulting principally from other causes. Three of the blowouts, or 5 per cent, resulted from insufficient fluid density in development operations.

2. **In exploratory operations,** it was found that five blowouts, or 9 per cent of those studied, were caused by insufficient fluid density, four of them occurring while drilling was in progress. The number of blowouts is higher for exploratory drilling than for development drilling since the formation-pressure characteristics are usually not known in exploratory operations. When an abnormally high formation-pressure gradient is combined with lost-circulation zones in the same open hole, it is obvious that considerable trouble can, and does, result in attempting to control potential blowout zones with the drilling fluid.

It is well recognized in field operations that severe gas cutting of the drilling fluid will reduce the effective static pressure at the potential blowout zone. This gas cutting may occur from (a) drilling into a sand with insufficient drilling fluid density to exceed the formation pressure or (b) contamination of drilling fluid by the gas present in the drilled-up section of the hole, even though the fluid density may adequately exceed the formation pressure.

The gas cutting caused by use of insufficient fluid density can be eliminated only by increasing the density to safely exceed the formation pressure. The contamination resulting from gas in the drilled-up section is supposedly minimized by drilling a gas sand slowly, or at a rate considerably less than that obtainable. In order to determine the significance of pressure reduction by gas cutting during drilling, it was assumed that a typical California gas sand was penetrated with a drilling rate of 60 ft. per hour, a circulation rate of 25 cu. ft. per minute, and a fluid density of 75 lb. per cubic foot. Neglecting temperature change and gas compressibility, it can be calculated that the penetration of this sand under these conditions may result in a pressure reduction at 5,000 ft. of approximately 90 psi.

At more normal rates of 30 ft. per hour for penetration and 50 cu. ft. per minute for circulation, some reduction in bottom-hole pressure will be obtained by gas contamination from the drilled-up section of the hole but the amount is negligible in comparison to the usual pressure excess of the fluid column. It may be concluded, then, that except at high drilling rates (above 60 ft. per hour) there is no appreciable benefit to be gained by the slow penetration of gas sands, provided a normal pressure excess is being maintained by the drilling-fluid column.

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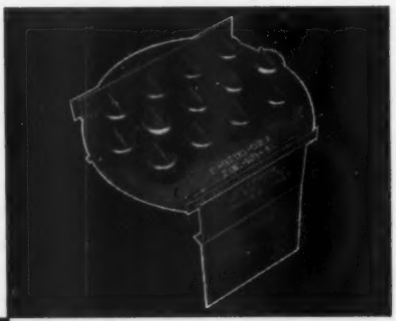

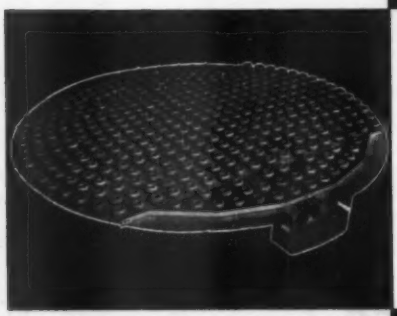

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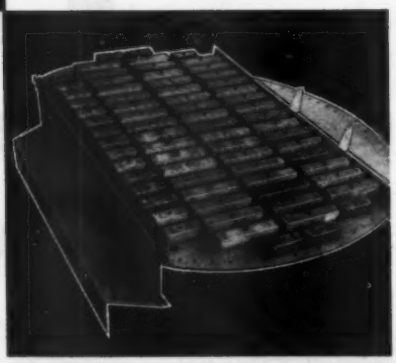

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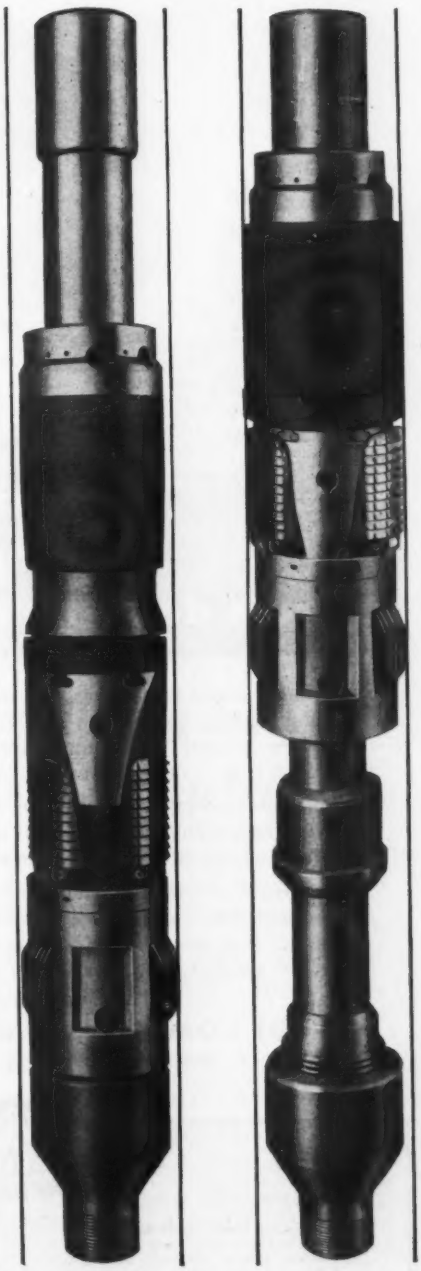

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tion by gas contamination from the drilled-up section may be hazardous when (a) the mud column pressure is only slightly greater than the formation pressure, (b) the gas contaminated fluid is recirculated without surface conditioning, or (c) a shallow high-pressure gas sand is exposed during gas contamination of the fluid from drilling in a deeper sand.

C. Reduction in Static Pressure by Pipe Withdrawal

The conclusion was inescapable in this review that the only possible reason for the loss of primary control in some cases has been a reduction in static head during pipe withdrawal by some means not related to the fluid level or density. Well histories have been studied where positive pressure differentials of 70 to 350 psi. existed over the formation pressure and satisfactory drilling progress was made. Yet, upon pulling the pipe upward to withdraw it from the hole or to retrieve a wire-line core barrel, a blowout has occurred within a short time. Nine of the well blowouts, or 16 per cent, resulted from this reduction in static pressure by pipe withdrawal.

Static pressure reduction by pipe withdrawal has been observed by several investigators.[3,6,7] Cannon[2] and coworkers conducted field tests to determine the magnitude of this effect and found that it depends on the length of pipe in the hole, the size of the annulus, and the gel strength of the drilling fluid.

The measurement of gel strength of the mud was arbitrary at the time Cannon's work was published (1934), as it still is today. It seems reasonable to assume, however, that all values of gel strength arbitrarily measured in Cannon's work may be repeated in field fluids. Therefore, we may estimate the degree of pressure reduction on the basis of these actual field measurements. For example, from Cannon it was found that the withdrawal of 3½-in. drill pipe from 5,000 ft. in 7-in. casing with a low-gel-strength fluid resulted in pressure reductions up to 250 psi. Then, even if low values of gel strength as measured by Cannon are accepted as representative of California field conditions, it appears possible to obtain an appreciable static pressure reduction by pipe withdrawal.

Static pressure reduction as a cause in well blowouts was found to be especially critical following cementing operations. After plugging with cement or drilling out cement, the drilling fluid usually has a high gel strength, even when the fluid is chemically treated for viscosity reduction. As a result of this high gel strength, pipe withdrawal during such a period will produce a large pressure reduction. If the drilling fluid density does not provide sufficient pressure excess, then the pressure may be lowered sufficiently to cause a well blowout.

In this study, it was difficult to determine accurately the proportion of well blowouts resulting from pressure reduction by pipe withdrawal because of the lack of basic data on gel-strength measurements. Many cases were associated with failure to keep the hole full. However, in cases of probable high gel strength from cement contamination and in cases where only a small amount of drill pipe had been withdrawn, it was assumed that the principal cause of these blowouts was pressure reduction by pipe withdrawal.

D. Failure to Keep Hole Full of Fluid

The effect of failure to keep the hole full of drilling fluid is, of course, the same as that observed with lost circulation, i.e., a lowering of the fluid level with consequent reduction in static head. It is a distinctly separate action from that of lost circulation, however, since it can be controlled at the surface. There is no valid excuse in drilling operations for this cause of well blowouts. Twenty-three blowouts of those studied, or 42 per cent, were caused by failure to keep the hole full.

It is usually found that this factor is of considerable importance in operations where (a) the drilling-fluid density provides only a small pres-

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sure excess over the formation pressure with a full column, or (b) a formation or water shutoff test has been made and a long column of closed drill pipe is being withdrawn from the hole.

This cause of blowouts has been divided further into those occurring.

1. During pipe withdrawal.
2. During other operations.

1. **During the pipe withdrawal** an approximation of the magnitude of the pressure reduction resulting from not filling the hole may be easily calculated. For example, in pulling 3½-in. drill pipe with an unplugged bit from a 6-in. hole filled with 80 lb. per cubic feet mud, there is a pressure reduction of about 7 psi. for each stand (90 ft. long) withdrawn. Poor field practice usually involves filling the hole after pulling 5 to 10 stands, thus resulting in a pressure reduction throughout the column of 35 to 70 psi. with open drill pipe. Most dangerous of all is the pulling of a plugged bit or a formation tester packer under these same conditions. In such a case a pressure reduction of 17 psi. per stand is obtained and, if the same hole-filling practice is followed, a pressure reduction throughout the column of 85 to 170 psi. results! Eleven of the blowouts, or 20 per cent, were a direct result of not filling the hole during pipe withdrawal.

2. **During other operations**—a factor often overlooked is the slow drop in fluid level during suspension of drilling for equipment repair or for economic reasons. With exposure of an appreciable amount of permeable formations to the bore hole, gradual loss of fluid and establishment of filtration equilibrium can lead to a significant decrease in static pressure at the blowout zone.

During equipment repairs on a recent well in the Ventura area, for example, it was found necessary to add drilling fluid to 7,000 ft. of open hole continually for over 3 weeks at rates decreasing from an initial 90 bbl. per day. This addition was necessary in order to maintain the fluid level at the surface, although no circulation loss during drilling operations had been previously noted. Six of the blowouts, or 11 per cent, were a result of not keeping the hole full while a slow loss of fluid to the formation was occurring.

Gun perforating of casing during completion or plug-back operations without maintaining the hole full of fluid resulted in three well blowouts. The cutting of casing with a subsequent drop in fluid level and exposure of a blowout zone without filling the hole was responsible for two blowouts.

In summary, 12 of the blowouts, or 22 per cent, were caused by not keeping the hole full during operations other than pipe withdrawal. All of these blowouts were avoidable if fluid had been continuously circulated into the hole.

2. Loss of Secondary Control Over Formation Fluid Pressure

The absence or failure of secondary-control methods cannot be considered principally responsible for a well blowout, since a failure of primary control by the drilling fluid usually must occur before secondary methods are applicable. However, the success of using surface equipment for shutting in a well is dependent upon adequacy of equipment, proper maintenance, and installation of suitable auxiliary fittings. For the proper functioning of this surface equipment the flow must be confined to the casing. When the fluid flow bypasses the casing and breaks to the surface at points outside the well head, then any amount or kind of blowout equipment will not avail to control this flow. The causes of loss of secondary control over formation pressure are as follows:

E. Insufficient blowout - control equipment.

F. Improper design or fabrication of blowout-control equipment.

G. Improper installation of blowout-control equipment.

H. Improper surface fittings for blowout-control equipment.

I. Improper well-casing program and cementing practice.

The percentages of well blowouts continuing out of control because of failure of these secondary control

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measures are indicated in Fig. 2.

E. The drilling of a well in hazardous territory with inadequate blowout control equipment is poor drilling practice and is not recommended. In 16 of the blowouts, or 29 per cent, efforts for shutting in the well were hampered by (a) complete absence of surface equipment, (b) pipe packoff equipment only with drill pipe out of the hole, or (c) complete shutoff gate only with drill pipe in the hole.

F. This factor involved a mechanical failure of the surface equipment because of poor design or construction. The three blowouts which continued out of control because of this type of failure took place prior to 1945, as considerable improvement has been made in this equipment during the past five years.

G. In approximately six of the well blowouts, or 11 per cent, secondary control could not be established because of the use of wrong equipment or parts for the actual or anticipated conditions. Installation of the wrong size drill-pipe rams, use of equipment not designed to withstand the anticipated pressures, failure to incorporate design changes recommended by the manufacturer, and lack of knowledge of the procedure for use were responsible factors in the six blowouts.

H. One blowout of those studied was directly attributable to improper surface fittings. In addition, the use of landing spools, pipe connections, and other fittings which were not able to withstand the maximum pressure exerted on the well head during a blowout have been responsible for lack of secondary control in three of the blowouts.

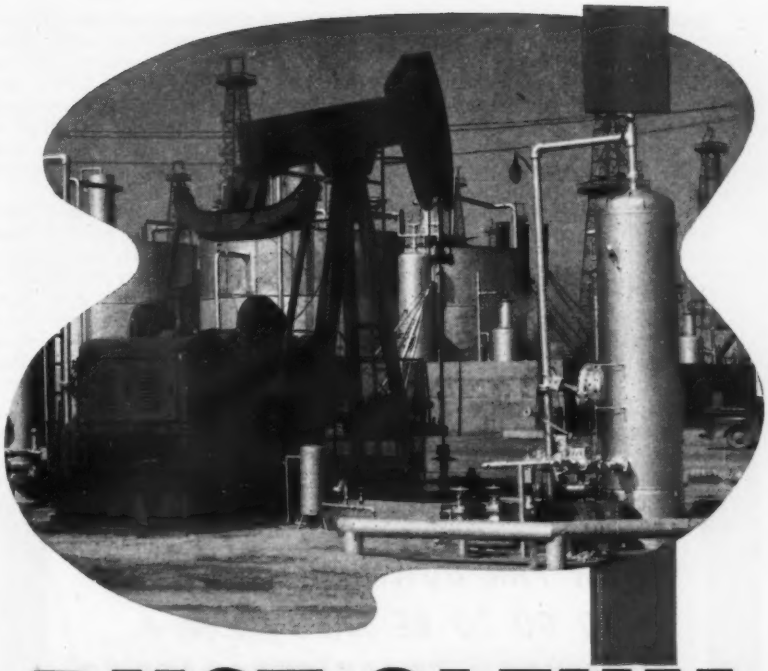
I. In six of the well blowouts, or 11 per cent, the formation fluid bypassed the casing, causing serious damage and considerable expense. This bypassing resulted from insufficient surface casing, casing failure, or an ineffective cement bond.

3. Prevention of Loss of Primary Control Over Formation Pressure

A. Reduction in Fluid Level by Lost Circulation

1. **General.**—The histories of surrounding wells in development and exploratory operations should be reviewed carefully to determine the lost-circulation zones and the depth relationship of these intervals to the blowout zone. The preparation of the drilling program, the amount of mud-storage facilities, and the purchase of mud materials depends upon the location and seriousness of these zones.

2. **Engineering planning.**—The nature and location of the lost-circulation intervals will determine the type and density of the drilling fluid and the well-casing program. On the basis of drilling experience in a particular area, consideration should be given to methods of precluding or



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overcoming lost circulation before drilling into the potential blowout zone by: (a) the addition of remedial materials; (b) the use of batches of rapidly mixed, high-viscosity mud; (c) the cementing of the loss zone. In the event that circulation cannot be satisfactorily maintained or recovered before penetrating the blowout zone, casing must be cemented to exclude the troublesome interval or pressure drilling surface equipment must be installed before proceeding.

3. **Operating practices**—The maintenance of adequate but minimum drilling-fluid density is necessary to preclude loss of fluid in troublesome areas. A sufficient supply of suitable remedial materials and mixed mud should be present at the rig site for immediate use upon encountering fluid loss. An adequate mud-cleaning system is required to prevent continuous increase in density by retention of cuttings in the fluid.

Although not generally the practice in California at the present time, considerable benefit may be expected in troublesome areas by the installation of a pit-level indicator with means for transmitting a continual record to the driller's position on the floor. It is suspected that often fluid losses increase gradually before complete loss is experienced and the indicator should provide easy observation of this occurrence in time for proper remedial measures.

After penetrating the potential blowout zone, the maintenance of low gel strength is recommended in order to prevent recurrence or initial breakdown of potential loss zones during the running of drill pipe. Proper conditioning of the mud to obtain low viscosity and gel strength is required prior to the running and cementing of casing because a large running-in pressure will be obtained with high-gel-strength fluid in the small annular space.

To avoid the chance for breakdown of possible or known lost-circulation zones in holes also exposing a potential blowout zone, it may be well to consider carefully the merits of reciprocation of the casing during cement displacement. A study of the magnitude of the pressure increases (and decreases) as reported by Cannon[2] indicates that it is doubtful if this cementing method should be used where danger of serious lost circulation exists.

Where serious losses may occur, cement containing bentonite or remedial material should be used as a means of preventing loss during displacement of the lower density mud by the cement slurry.

When a fluid change is made during completion operations from a normal water-base or oil-base drilling fluid to a circulating fluid composed of only water or oil, extreme care should be exercised to maintain a full column of fluid and to prevent any contamination of the fluid by formation gas. In the event that either of these precautions cannot be followed with a potential blowout zone exposed in the bore hole, a change to a suitable fluid should be made immediately.

B. Insufficient Drilling-Fluid Density

1. **General**—Ordinarily there should be no excuse for a blowout from the objective zone of a development well because of insufficient mud density, in the absence of lost-circulation difficulties. In the usual complexly faulted fields of California, however, there is always the possibility of penetrating a previously undrained or unknown reservoir, particularly that of a shallow gas accumulation.

It has been the practice of at least one operator in California to maintain a drilling-fluid density which will provide a static pressure of not less than 500 psi. in excess of that required to balance the formation fluid pressure at depths below about 3,000 ft. A similar minimum pressure excess is used in other drilling areas. From the determinations involving gas cutting, static pressure reduction by pipe

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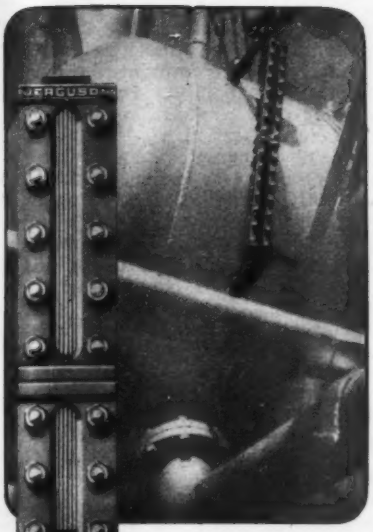

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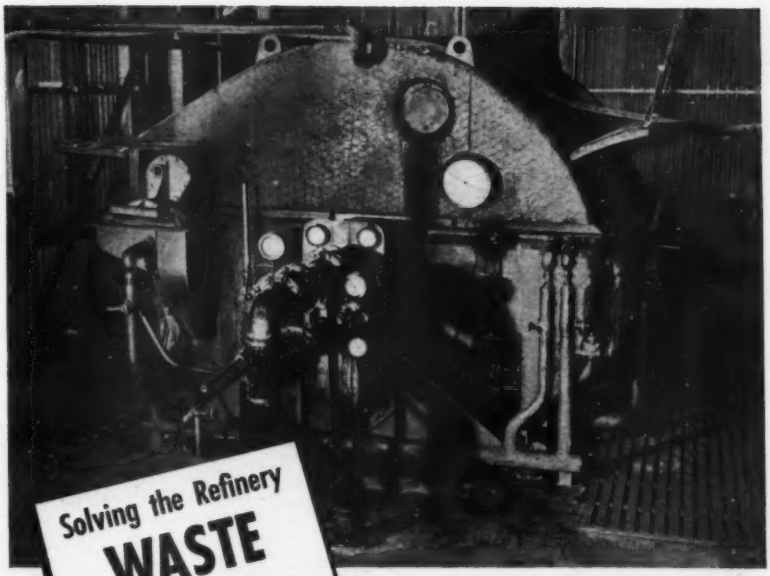

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withdrawal, and the possibility, but bad drilling practice, of infrequent hole filling, it appears that this pressure excess is a reasonable minimum to be maintained. In many drilling operations, the pressure differential probably is considerably greater than this amount.

The use of a pressure excess greater than 500 psi. is not recommended as a general practice because of the added drilling-fluid maintenance cost, the increased danger of loss of circulation, and the greater filtrate invasion and wall-cake thickness within the productive section. It is regarded as a poor economic policy to increase the density of the drilling fluid to an excessive value in order to preclude failure on the part of drilling personnel to maintain a full column of fluid to the surface at all times.

2. **Engineering planning** — The choice of drilling-fluid density should be based on that required to successfully drill nearby development and exploratory wells with similar casing programs and objective zones. For those exploratory operations in areas where little or no drilling has been done previously, formation characteristics should be estimated by consultation with the geologist. Areal consideration of formation pressure characteristics in the particular geologic province will not necessarily indicate, however, the drilling-fluid pressure required at a particular location.

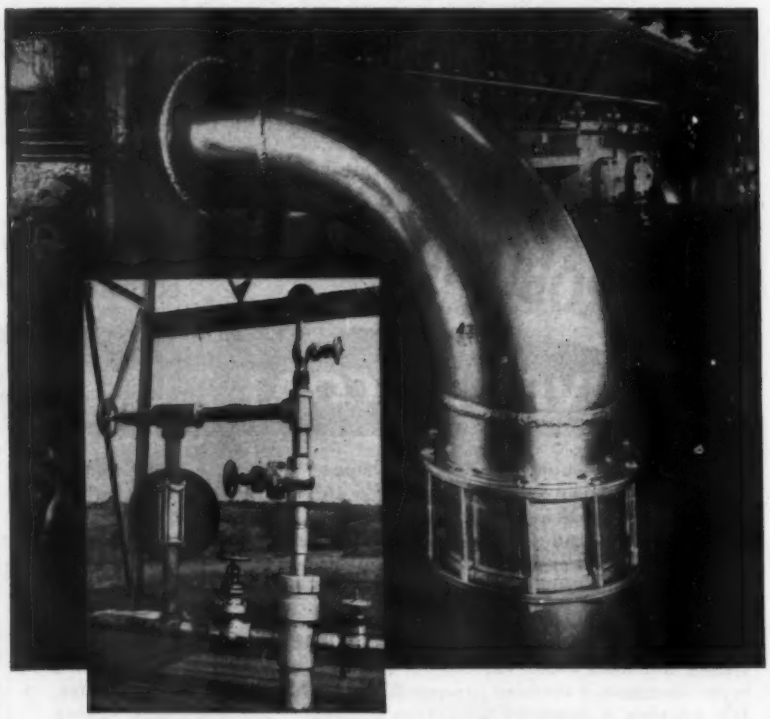
In development operations, adjacent electric logs should be analyzed carefully for possible shallow gas accumulations above the objective zone, particularly in complexly faulted fields. The investigation of well blowouts has found that these shallow gas sands usually exhibit abnormal pressures. Therefore, an arbitrary pressure excess, say 500 psi., may require a considerably higher drilling-fluid density than that indicated by consideration of only the objective zone pressure.

In the case of a shallow gas sand near 2,000 ft. with a formation pressure gradient equivalent to the hydrostatic gradient (0.44 psi. per foot), a pressure excess of 500 psi. requires a drilling-fluid density of 100 lb. per cubic foot. Since static pressure reductions from the causes previously discussed are of less magnitude at the shallow depths, this 500-psi. pressure excess is often not maintained. In addition, because of lost-circulation difficulties and drilling economics, it is usually not practical to use such high fluid densities. Hence extreme care should be taken, when drilling into or through shallow gas sands, to provide minimum pressure reductions from the various causes discussed above.

The casing program should be reviewed for the possibility of cementing the surface casing or a protective string in a competent shale below possible or known shallow gas sands in order to exclude them from the hole before further drilling, particularly if loss of circulation is anticipated below high pressure gas sands.

3. **Operating practices.**—For water-base drilling fluids, the choice of clay will depend on the density required to control a potential blowout zone and yet permit penetration of lost-circulation zones. The various bentonites and commercial clays in California provide fluid densities from 67 to 85 lb. per cubic foot without weighting agents. If it appears that densities will be required at values above this range or if it is desirable to use a lower-density type of bentonite or commercial clay, then sufficient additional weighting material should be maintained at the rig site so as to be readily available at the time of a potential or actual well blowout.

It is desirable to install a mud density meter on all exploratory wells and on those development wells which are drilled in areas of abnormal pressure gradients. A recording feature should be included with this instrument, as in the case of the pit-level indicator. The driller is then aware at all times of the



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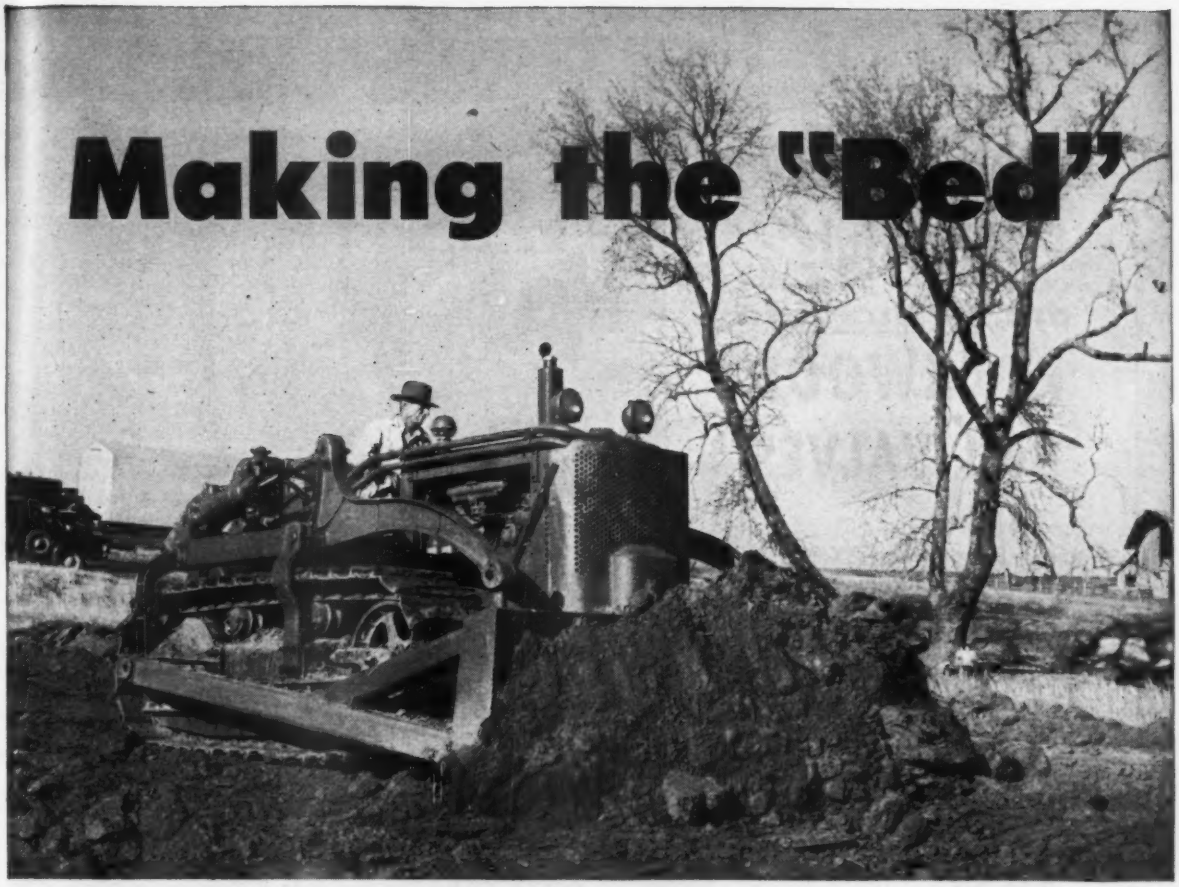

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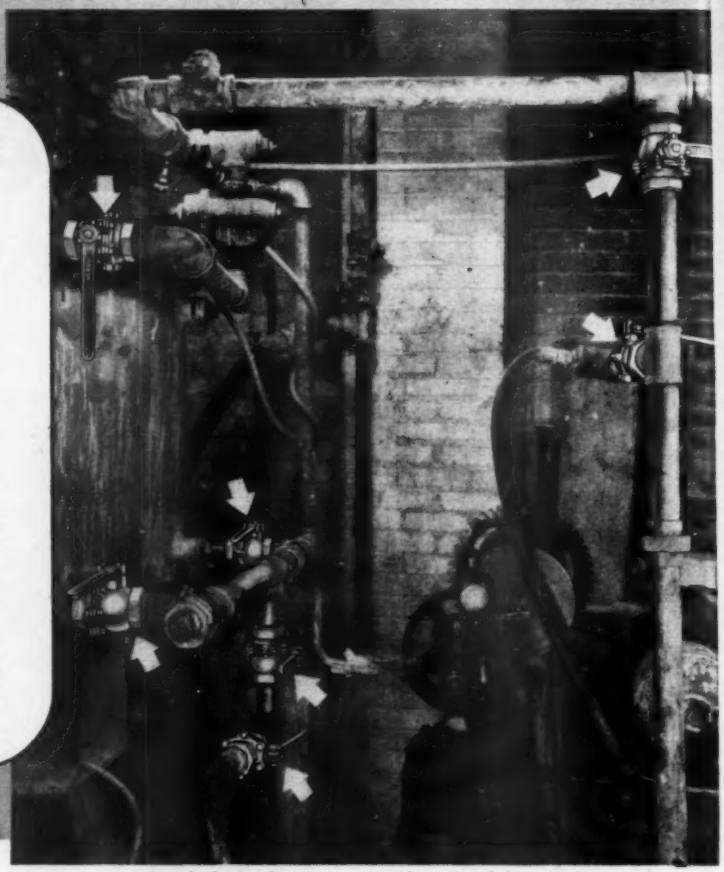

Actual photo taken at Iroquois China Co., Solvay, N. Y.

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circulating fluid density, thus being warned of any contamination of the fluid by extraneous gas or water entry as soon as the fluid reaches the surface.

The fast penetration of gas sands during drilling has long been regarded as a possible cause of well blowouts. However, at rates of penetration prevalent in California gas development fields, this is not believed to be a cause of well blowouts provided a reasonable pressure excess by the drilling fluid and a normal circulation rate are being maintained. On the other hand, extreme gas cutting from drilling into a gas sand will reduce the effective mud-column pressure on that sand and, to a greater degree because of gas expansion during circulation, or any shallower sands. When a gas-cut fluid column exisits in the hole, the withdrawal of pipe with its accompanying pressure drop may reduce the effective static pressure sufficiently to allow formation fluid to flow into the hole, particularly from the shallower sand.

In areas of potential blowout zones, the drilling fluid should be observed continually for possible gas and salt-water contamination. The gas observation is aided by the installation of a gas detector on the ditch with recording attachment or warning bell near the driller's position on the floor. If gas contamination of the fluid occurs, the fluid should be immediately degassed by the use of a riffle tower or by violent stirring of the suction tank with a standby pump or portable tank agitator. Periodic salt content determinations should be made on the drilling fluid filtrate from the surface filter tester, particularly on exploratory wells being drilled in areas of known high-pressure salt-water zones.

C. Reduction in Static Pressure by Pipe Withdrawal

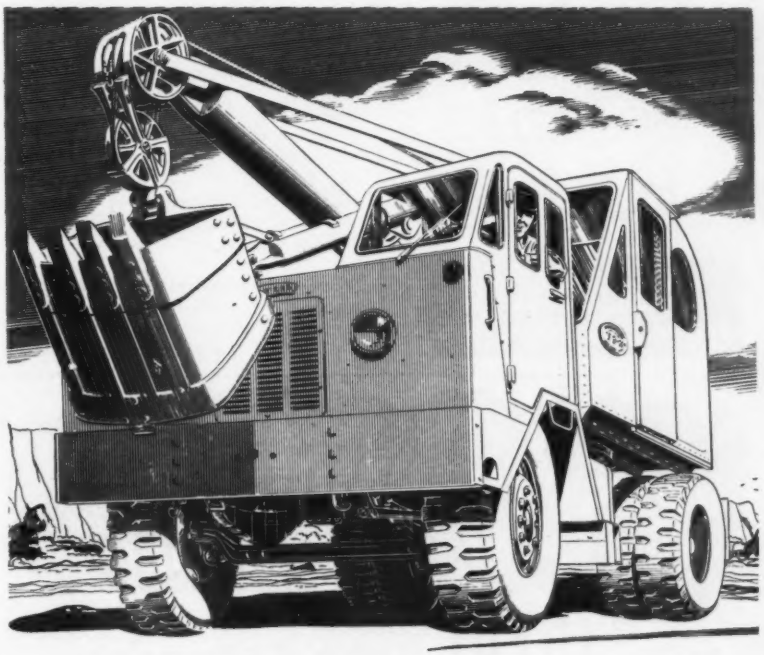
1. **General.**—The importance of the gel strength of the drilling fluid in determining the magnitude of the pressure reduction in this phase of the operations has been previously emphasized. It should be remembered that the pressure reduction obtained by pipe withdrawal is proportional to the gel strength, the length of pipe in the hole, and the size of the annulus; that it exists throughout the column above the bottom of the pipe in proportion to the depth considered; and that it is present at a maximum from the bottom of the pipe to the effective depth of the hole.

The pressure reduction in this process is sufficiently important to justify further experimentation to determine its magnitude with various types of drilling fluids in field use. The first step in this investigation is to determine a standard absolute measurement for the gel-strength property of drilling fluid, as has been previously suggested by W. T. Cardwell, Jr.[3]

2. **Engineering planning.**—This static-pressure reduction is principally an operating problem encountered only during drilling. Assistance should be furnished to the operating group in the estimation of the importance of the factor, as determined by the drilling-fluid quality, and in the mud-conditioning technique which may be applicable for obtaining a minimum gel strength.

3. **Operating practices.**—It is particularly important that a minimum drilling-fluid gel strength be maintained during and after the penetration of potential blowout zones. The maintenance of low gel strength is necessary after cementing operations with exposure of the potential blowout zone to the bore hole. Since the gel strength is usually at a maximum after cementing casing or plugging, every precaution should be taken during subsequent pipe removal until the mud can be conditioned for a reduction of gel strength.

As noted by Cannon[2] and as can be substantiated by laboratory simulation of the problem,[5] the amount of pressure reduction has no apparent relationship to the speed of pipe withdrawal. Consequently, it is suggested that no attempt be made during normal drilling, coring, or even testing operations to re-



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duce the speed of pulling out. Instead, every effort should be made to maintain a low gel strength in the drilling fluid, particularly when using large-diameter drilling tools, prior to pulling them out of the hole under critical conditions.

In the event that drilling operations, such as coring in reduced hole, must proceed without the possibility of maintaining a low or reasonable gel strength and annular space, consideration should be given to increasing the density of the fluid in order to maintain a satisfactory pressure excess on the potential blowout zone during pipe withdrawal periods.

D. Failure to Keep Hole Full of Fluid

1. **General.**—The occurrence of a well blowout from a loss of primary control because of failure to maintain the hole full of drilling fluid, in the absence of lost-circulation difficulties, appear to be inexcusable. In the event that the hole is not kept full during pipe withwithdrawal, the pressure reduction by drilling-fluid gel strength need be only a fraction of the minimum obtainable value to cause a sudden and disastrous return of the fluid to the surface.

2. **Engineering planning.**—There is no method or amount of planning which can circumvent a well blowout caused principally by failure to keep the hole full during the pulling and running of pipe, or during other well operations, as outlined above.

3. **Operating practices.**—It is obvious that the only method to assure that the hole is full at all times is to maintain continual circulation into the annular space through the fill-up line at the well head. It has been seen that the pressure drop is not large for withdrawing an appreciable amount of pipe, say five stands, provided that the pipe is properly draining during the time of withdrawal. This proper draining of the pipe cannot always be assured, even with the practice of pumping in a high-density "pill" just before pulling the pipe, since bit plugging may occur at any time from improperly mixed mud or cuttings.

On the other hand, the withdrawal of closed pipe, such as with a plugged bit or formation-tester packer, is a dangerous operation if the hole is not kept full at all times when a potential blowout zone is exposed. To be assured that an adequate fluid pressure is being exerted on the dangerous zones, it is imperative that the hole be filled continuously while withdrawing drill pipe.

In the event that it is mechanically impossible to keep the hole full with the available drilling equipment, it should be mandatory that no more than five stands (each 90 ft. long) of properly draining pipe and no more than two stands of closed pipe should be withdrawn without stopping to fill the hole, when potential blowout zones are exposed. In order to save rig time and reduce the drilling expense, it appears economically sound to install a small-displacement auxiliary pump and low-horsepower prime mover.

Upon suspension of drilling or during operations involving gun perforating or casing cutting, the hole must be kept full at all times to insure that adequate control of formation pressures is being maintained. If this not possible, the installation and use of adequate blowout equipment is strongly recommended for wells exposing potential blowout zones.

4. Prevention of Loss of Secondary Control Over Formation Fluid Pressure

E. Insufficient Blowout Control Equipment

1. **General.**—It is obvious that the failure by the drilling fluid to maintain primary control over the formation pressure and the absence of adequate surface equipment for secondary control will result in, stated conservatively, a quite serious situation!

The use of only one type of control equipment, such as either a complete shutoff gate or annular

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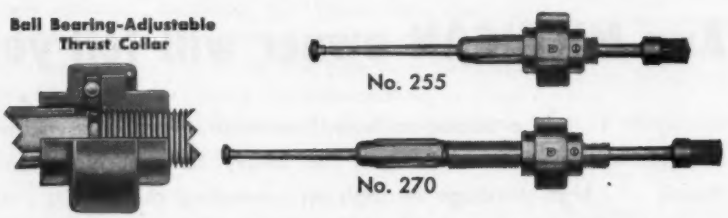

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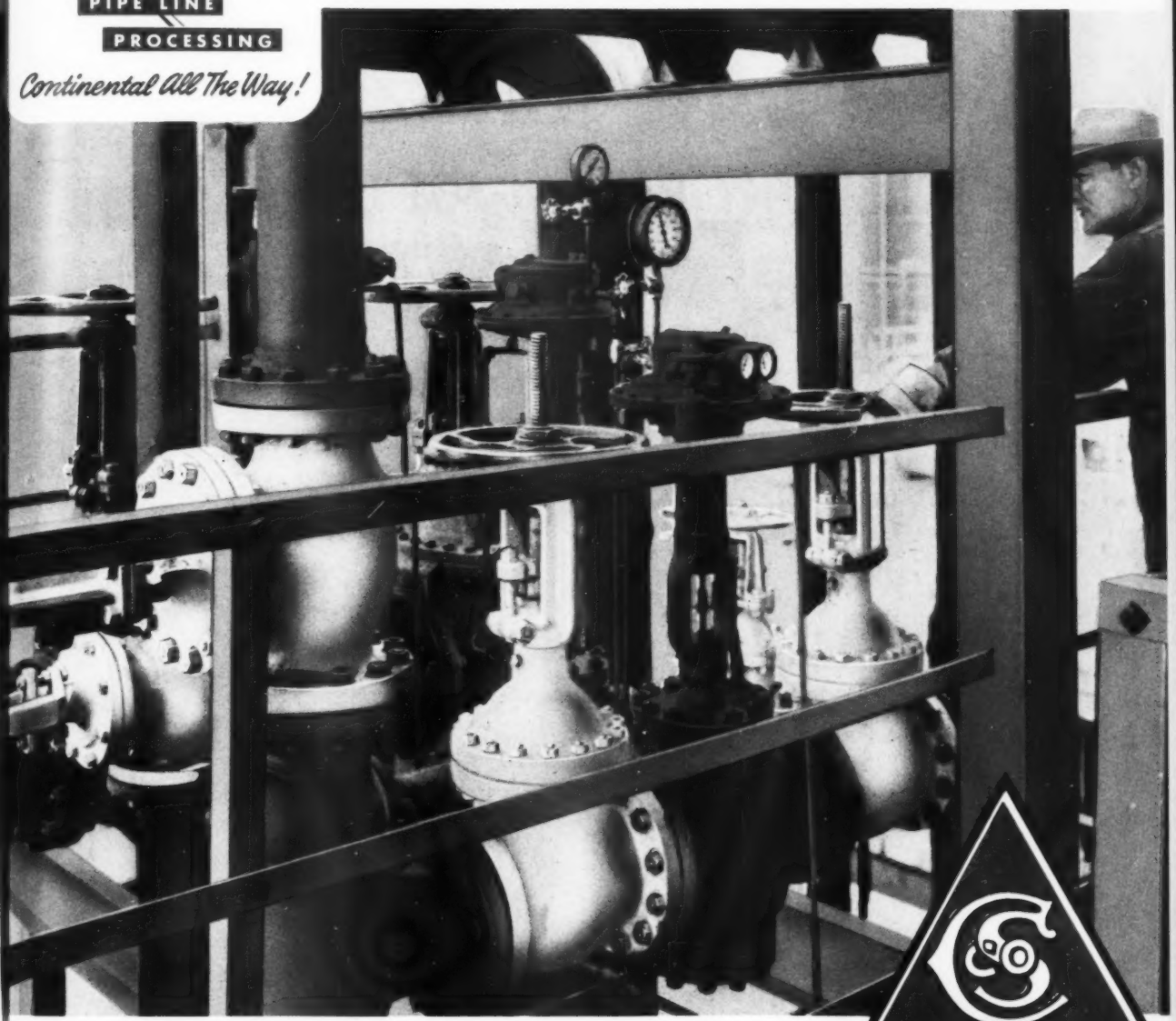

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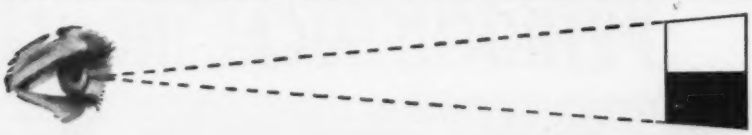

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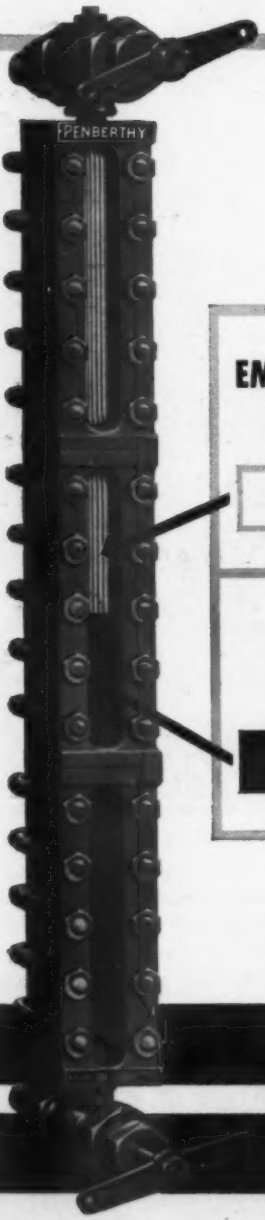

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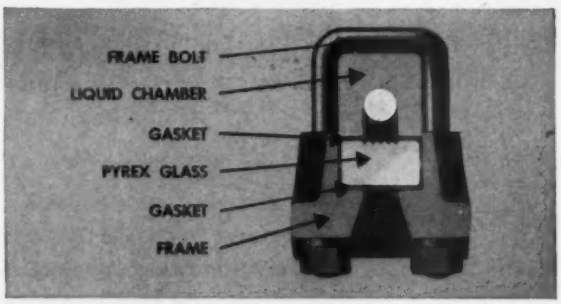

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closure device, should be discouraged in favor of adequate equipment. Nevertheless, one kind of control equipment is operationally better than none at all. The State Division of Oil and Gas requires adequate blowout control equipment in any subsurface drilling during which potential blowout zones or intervals of flowing production may be penetrated.

2. **Engineering planning.** — In any drilling operation in which potential blowout zones may be encountered, consideration should be given to the installation of all three general types of blowout control equipment, namely:

(a) Complete shut-off gate or solid rams,
(b) Drill-pipe ram-type closure, and
(c) Bag-type closure.

It is beyond the scope of this paper to evaluate the relative importance of the above types of equipment, but the blowouts studied indicate that each of the three methods has been used successfully under appropriate conditions for obtaining secondary control over the formation pressure. The complete installation of the three general types should be made on all exploratory operations and on those development operations where high-pressure shallow gas sands are known to exist.

During drilling, redrilling, repair, or abandonment operations, a large operator classifies the well on the basis of the known or anticipated formation - pressure characteristics. The type of blowout equipment to be installed on the well is then determined according to this classification. (See Table 1).

Additional consideration should be given to the installation of pressure drilling equipment in areas where potential blowout zones have pressure gradients near the geostatic gradient and where serious lost-circulation difficulties may be encountered. Although the high installation cost of this equipment will increase the total drilling cost, the equipment is available for immediate use when conditions require it.

3. **Operating practice.** — The use of inadequate blowout-control equipment should not be tolerated in an area of potential blowout zones, if at all possible. In the event that it is necessary to proceed in this manner because of economic or material limitations, every possible precaution should be observed in preventing a loss of primary control by proper drilling practices and drilling-fluid maintenance.

F. Improper Design or Fabrication of Blowout Control Equipment

1. **General.**—The proper design of blowout-control equipment depends upon the availability of complete information from the operators on the maximum pressures to which the equipment might be subjected and on the operating limitations at the field installations. In order to assist the manufacturer in designing and constructing better equipment, every case which is suspected to be attributable to this item should be carefully reviewed with the manufacturer's representative, furnishing as much information as can be salvaged from the event.

G. Improper Installation of Blowout-Control Equipment

1. **General.** — In contrast to improper design or construction, the installation of the equipment is a function of drilling personnel and supervisors, and they are responsible for this factor in loss of secondary control.

2. **Engineering planning.** — The proper installation of the equipment involves the selection of equipment types and equipment parts which will be adequate to withstand the maximum surface pressures which may be encountered in the drilling operations when there is a failure of primary control by the drilling fluid. In addition, it is necessary that suitable maintenance procedures be established and reviewed with the

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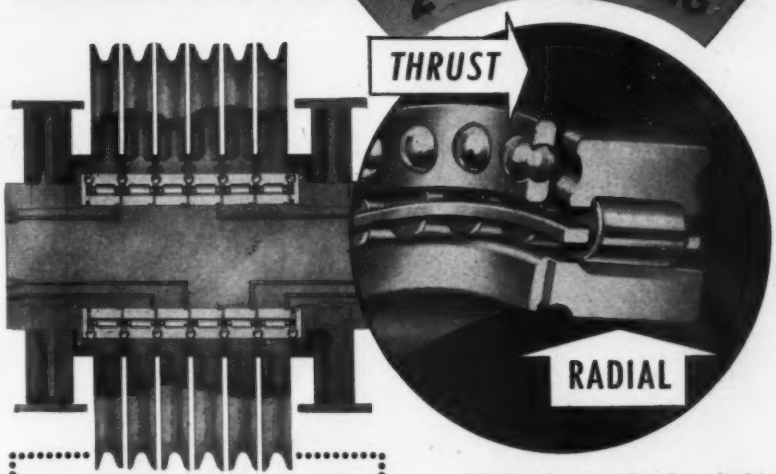

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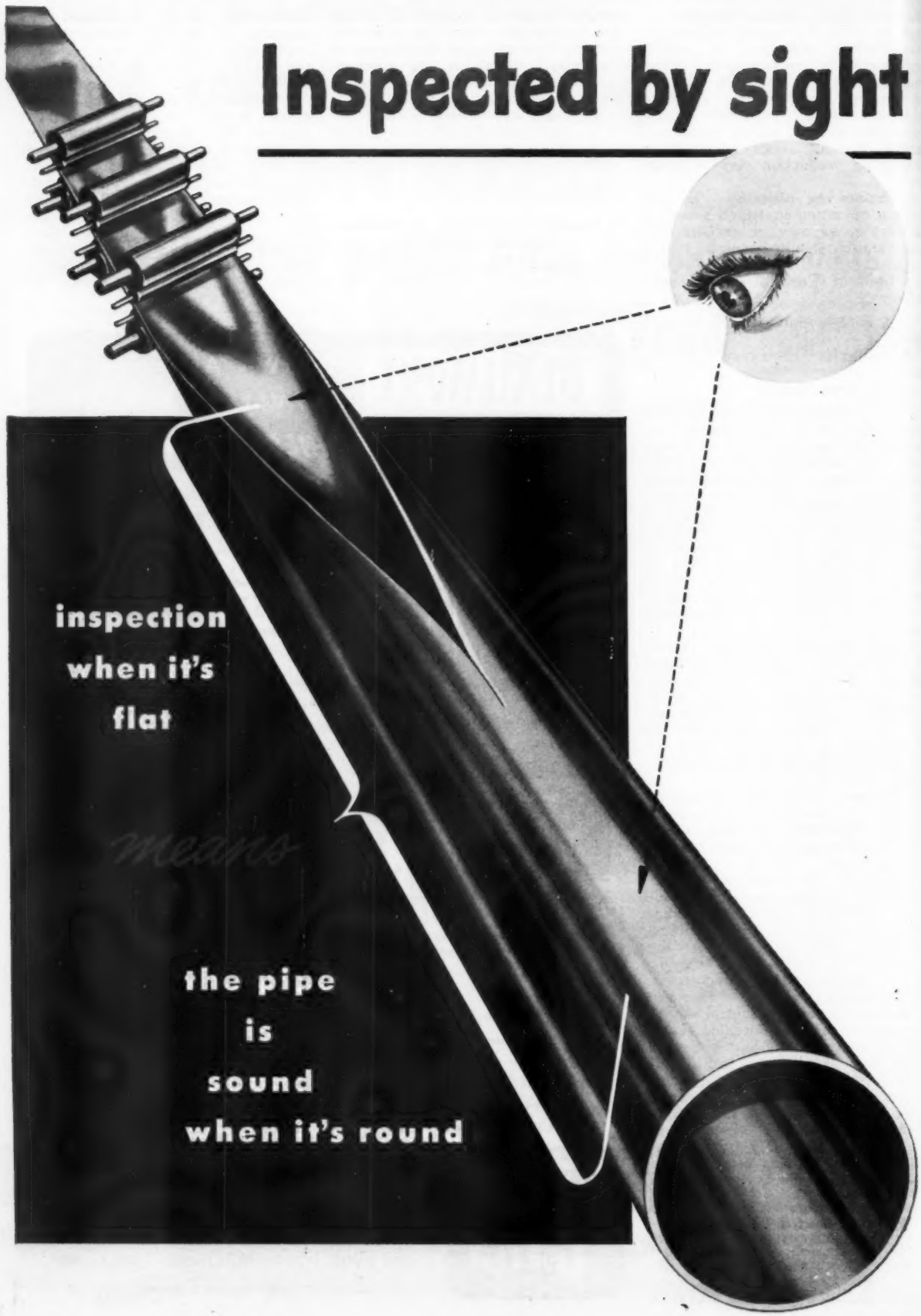

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operating group so that proper functioning of the equipment may be expected at all times.

3. **Operating practices.** — The most important responsibility of the operating group is the proper maintenance of the blowout-control equipment. A preventive-maintenance program for the equipment should be established and include the periodic disassembly of the installation, say every month, and the periodic replacement of all moving parts, say every 6 months or after severe usage. Several operators provide that the inspection and replacement work be performed at the rig during periods of cessation in drilling operations, such as after casing cement jobs and during rig moves.

In addition to the proper initial installation and periodic maintenance work, it is important that the equipment contain parts which are designed for the drill pipe or casing string which may extend through the equipment. A dangerous and embarrassing time is experienced when a blowout occurs with drill-pipe rams in the equipment body and with casing extending through the control equipment!

An important part of a maintenance program involves the periodic actuating of the equipment during the drilling of the well. It is, of course, rarely possible to test the equipment under pressure, this usually being done after cementing of the casing and before drilling out of the shoe.

On the other hand, there is no clear reason why the equipment cannot be periodically closed and opened in order to be assured that the moving parts are functioning properly and that there has been no recent damage to them. Field opinion varies on the period during which this testing should occur but it is generally agreed that the time between tests should not exceed three days.

In line with the periodic testing of the equipment, it seems obvious that those responsible for its use at the critical time should also be tested in the operation of the equipment. The idea of a "blowout drill" is not new,[48] but it has rarely been observed in field practice. There is no intention here of instituting the "surprise" type of action developed through the medium of a false alarm. Rather, the manipulation of the controls should be performed by each member of the drilling crew.

With the various positions of control points (e.g. floor, ground, casing rack) and the various methods of pressure application, e.g. hand, gas, liquid), it seems only reasonable that every crew member should be thoroughly familiar with the control methods, particularly on exploratory type drilling wells.

H. Improper Surface Fittings for Blowout Control Equipment

1. **General.** — Since the chain is only as strong as its weakest link, it is obvious that all pipe connections, flanges, and other fittings be designed to withstand the maximum pressure which may be reached in the use of the blowout-control equipment. Since improper fittings were directly responsible for one well blowout and for delay in controlling several others, it is suggested that considerable care be taken to use the correct fittings and that the installation be checked before being placed in operation.

I. Improper Well-Casing Program

1. **General.** — The design of the well-casing program also determines the success of secondary-control measures, since the best blowout-control equipment is rendered ineffective when formation fluids are allowed to bypass the casing through the annulus or through incompetent surface formations.

2. **Engineering planning.** — The considerations involved in determining the number and setting depth for the various casing strings should include the depth to the base of incompetent fresh-water sands and gravels, the competence of the

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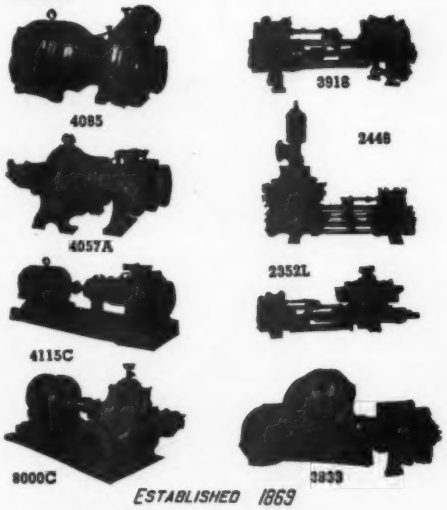

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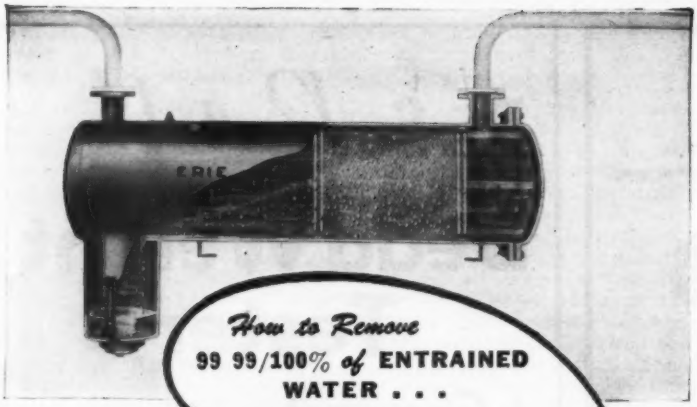

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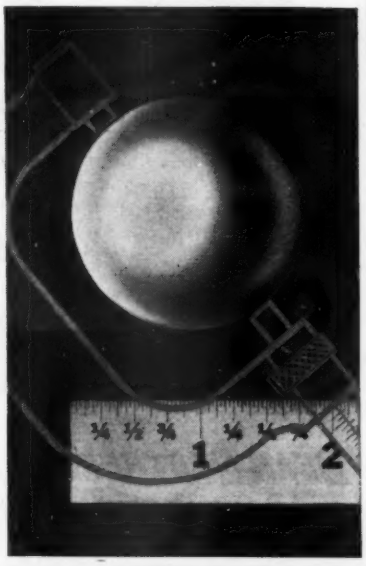

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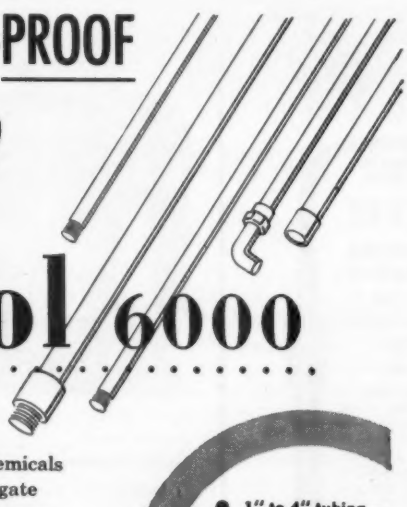

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shale at the setting depth, the occurrence of lost circulation above the setting depth, the proximity of the shoe to the blowout zone, and the possibility of lost circulation between the blowout zone and the casing shoe next above. To preclude bypassing of the casing, the surface casing should be cemented sufficiently deep, consistent with economic drilling practices, to exclude incompetent surface formations in areas where shallow gas accumulations may be present at abnormal pressures. If the interval above the blowout zone is not subject to loss of circulation, the best practice is believed to be that of cementing the surface casing or protective string through the potential blowout zone, thus excluding it from the bore hole.

To prevent or reduce channeling of the cement during casing displacement, it is believed to be good practice to equip the casing at various points with scratchers and centralizers. A continuous cement bond is necessary for the prevention of bypassing of the casing by fluid flow during a blowout and for the proper exclusion of potential blowout zones which may be located above the shoe depth. In this respect, however, previous precautions relative to reciprocation of the casing during displacement should be revised.

3. **Operating practice.**—The sufficiency of the casing length is equal in importance to the efficiency of the cement displacement. Recent publications, such as the Howard and Clark investigation, adequately discuss various methods of obtaining a good cement bond between the casing and the formation.

From the blowout viewpoint, the dangerous phase of casing cementing operations occurs during cement displacement with the possibility of lost circulation reducing the fluid head over a potential blowout zone.

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Blueprint for an

Industrial Safety Organization Plan

by G. L. Farrar* and A. M. Platt*

THE great majority of industrial concerns have good safety programs administered by safety groups or departments. These groups set the safety policies of the whole plant and make necessary provisions for the over-all safety program.

The plan herein described is not designed to replace this safety program, but should be considered as a supplement to it. There are several advantages to the proposed plan.

Experience has proved that a safety program is much more readily received and is more successful if means are provided for active participation in the program by the employes. This program provides opportunity for this participation by rotating the responsibilities of execution among all the affected people. Safety consciousness is greatly increased by this procedure, and accident rates and accident hazards are reduced, because the interested personnel know intimately the dangers inherent in a particular process or operation.

It should be pointed out that prompt action concerning proposals arising from the operation of this plan is necessary on the part of management. Otherwise, the enthusiasm of the workers for the safety program quickly dies.

Setup Similar to Magnolia Program

The proposed setup is similar to a plan initiated by the authors at the field research department of Magnolia Petroleum Co. in Dallas. Excellent results were obtained in a pilot-plant operating group in that organization. The plan has been modified in light of results obtained during its operation at Mognolia and subsequent experience.

Heart of the plan.—The program is the division of the plant personnel into various groups, based on functional similarities, physical locations, organizational lines, or on any other convenient, natural lines. Each group is then organized into a substantially independent safety group. The three major purposes of the safety program of this group should always be kept in mind:

1. Accident hazards should be reduced, and every effort made to lower the accident frequency rate.

2. Safety consciousness should be stimulated and good housekeeping strongly encouraged.

*Department of Chemical Engineering, Texas Agricultural and Mechanical College.

REFERENCE ENGINEERING SECTION

3. Each and every employe should be encouraged and given means to express freely his thoughts for promoting safety.

The details of organization will vary somewhat with each group, depending on the types of personnel included in that group. However, the groups will proceed in a similar manner on matters of importance. The plan henceforth presented will apply primarily to an operating group containing process engineers and operators.

The area included in the scope of the operating group **should receive two inspections each month** and the group should hold **one safety meeting** each month.

The **first inspection** should be rather detailed and time consuming, with attention being given to any item concerned in any way with unsafe equipment and/or unsafe practices.

The **second inspection** is made just prior to the safety meeting; its primary purpose is to check on the status of unsafe items brought to light during the first inspection. The meeting agenda includes a discussion of these items, along with other pertinent items as later described.

The **safety organization** is directed by a chairman chosen from the engineers of supervisory status and operators of head operator (or similar) status in the section. The chairman should serve for a period of 3 months and actively supervise the working of the safety program. His duties may be summarized as follows:

1. He selects one engineer and one member of the operating personnel to make the monthly inspections. He also sets the inspection dates.

2. He supervises the writing, approval, and issuing of the safety progress reports and the minutes of the monthly safety meetings.

3. He presides at the monthly meetings.

4. He may at any time inspect any area included in the section to determine the existence of safety hazards and/or unsafe practices. He may make recommendations for dealing with any hazards thus located.

5. He should, in consultation with the safety section, make decisions involving the feasibility of installation or use of any item of equipment specifically designated for safety purposes.

Safety inspections are made by the two inspectors, appointed by the chairman. These men are selected in rotation and serve 1-month terms. They issue two reports, and are especially diligent during their terms as inspectors to observe safety practices, safety hazards, and practice of good housekeeping within the section. The duties of these men are as follows:

1. Upon the advice of the safety chairman they make a safety inspection and prepare a safety report covering findings from the inspection.

2. A check inspection is made after the issuing of the report and before the safety meeting to determine the status of items needing correction.

3. One of the inspectors acts as secretary for the safety meeting. He appends a report on the check inspection with the minutes of the meeting.

Every person in the group is a member of the safety organization and each one is expected to use due care with regard to safety in the performance of his work. Company management usually shows a very liberal attitude in providing time and materials for the execution of a thorough safety program, and the responsibility for conducting the program rests with the personnel of the group.

The **initial inspection** is made by the selected personnel 3 weeks before the meeting at which the report is to be discussed. This is done to permit **writing the report** and issuing it 2 weeks before the meeting. On the day of the meeting a check inspection is made to determine the action taken on items discussed in the report. The interested supervisor is contacted to ascertain whether steps have been taken to correct items still requiring attention. Notes on these findings are made and used for discussion during the meeting.

The following outline includes some of the items to be checked during inspection:

I. Clothing

A. Are goggles, safety glasses, or face shields being worn?

B. Are safety shoes and/or hats necessary?

C. Is clothing adequate for protection against the hazards of the proc-

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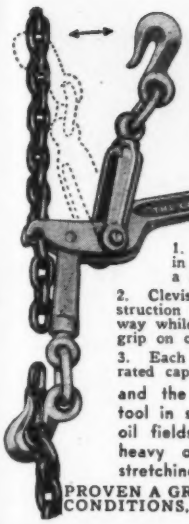

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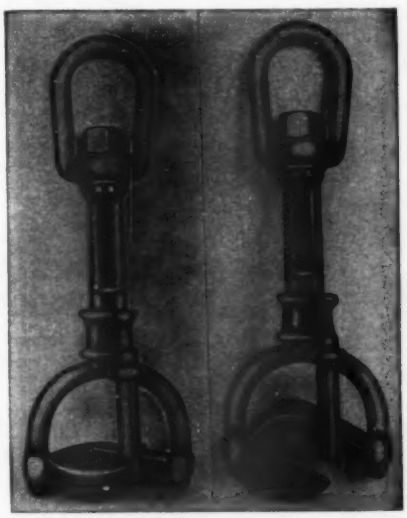

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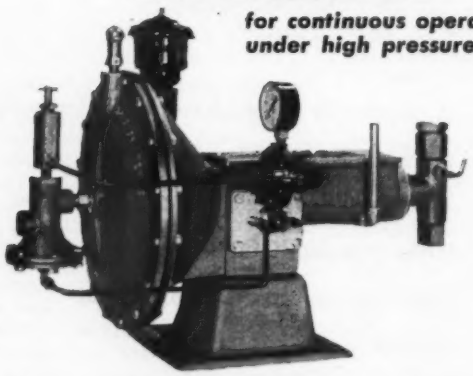

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B. Is material stored in proper places?

C. Check condition and location of hoists.

D. Are safe practices used in handling material?

III. Machine Guards

A. Check location of moving parts and note clearance for personnel.

B. Check for suitable guards over moving parts.

IV. Floors

A. Are floors smooth and free from nails, bolts, fittings, or projections?

B. Are they free from oil or water?

C. Are surfaces skidproof near moving machinery?

D. Check danger zones for leaking chemicals.

V. Tools

A. Are all tools in proper condition?

1. Note sprung wrenches.
2. Burred chisel or hammer heads.
3. Broken or split handles.

B. Are tools kept on toolboard when not in use?

C. Are tools or other materials left in unsafe places, e.g., overhead beams or platforms?

VI. Lighting

A. Is every point of operation adequately lighted?

B. Are light bulbs and reflectors clean?

VII. First Aid

A. Is it available near unit?

B. Is stock of supplies in standard kit complete?

C. Are special remedies required by unusual chemical injuries provided at hazardous locations and are instructions for use known and available?

D. Have all operators had first-aid training within the past 2 years?

E. Are men familiar with procedure for obtaining aid for the injured?

VIII. General

A. Are all safety devices provided in operative condition?

B. Is equipment arrangement hazardous?

1. In routine operation.
2. In making repairs or starting up.

C. Is ventilation adequate?

1. In routine operation.
2. In case of leaks.

D. Ask for suggestions from the operators.

IX. Electrical Equipment

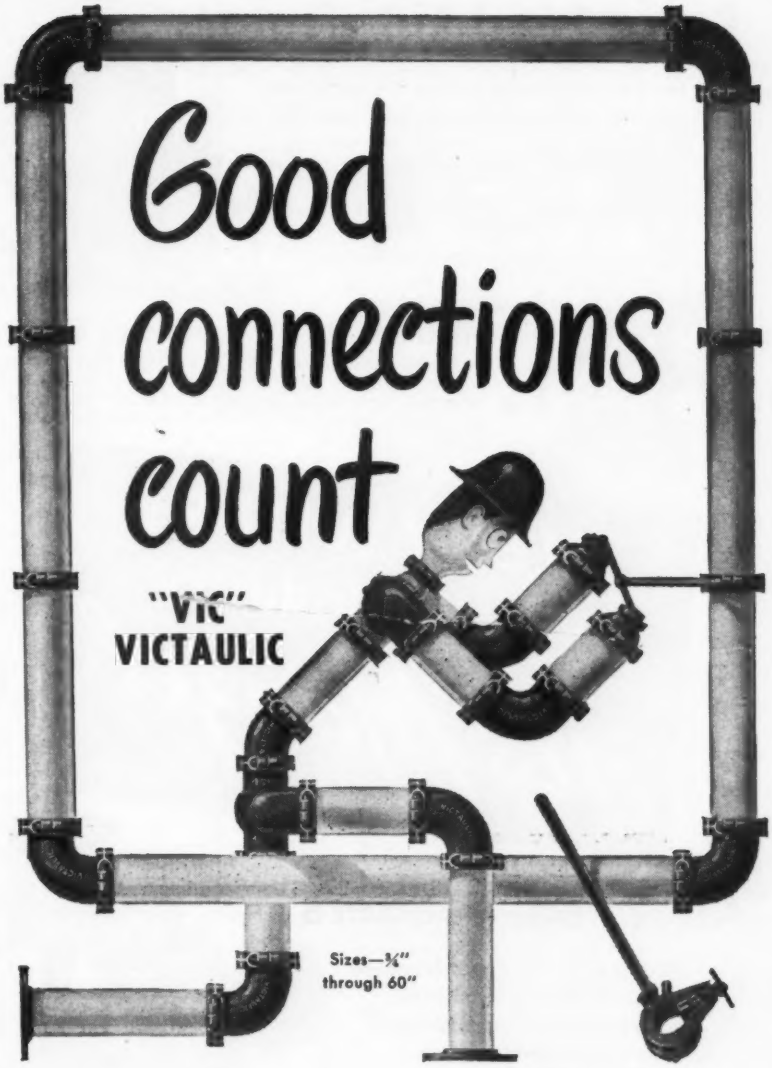
A. Check extension cords for breaks in insulation and for good connections.

B. Are outlets in good order?

C. Does any equipment overheat?

D. Are all switch boxes and fuse boxes protected against leaking chemicals?

E. Is explosionproof equipment used throughout the areas designated?



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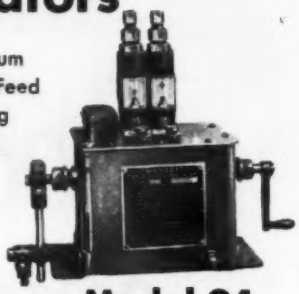

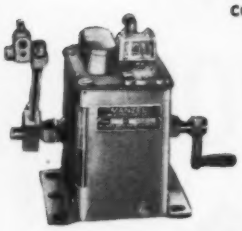

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Double Plunger Type. One to thirty feeds. Each feed adjustable, from fraction of a drop to 13 drops per stroke.

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Liquid Sight Feed Type. Suitable for pressures up to 3,000 lbs. Handles oil of any viscosity, delivering it at regular intervals.

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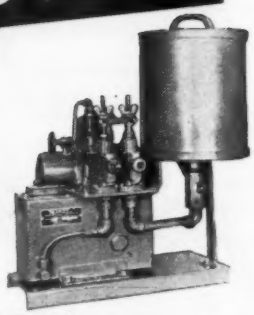

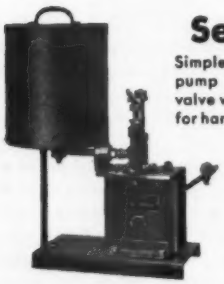

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Built on the same principle as the series "60" but larger and heavier. Handles chemicals in much greater quantities.

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DIVISION OF FRONTIER INDUSTRIES *Inc.*

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X. Good Housekeeping

A. Is discarded or broken equipment kept at the unit?

B. Are properly labeled waste cans available and in proper use?

C. Are waste cans emptied daily?

D. Are aisles and passageways blocked with projections or materials?

E. Are barrel trucks left in aisleways?

F. Are materials poorly stacked so that there is danger of falling?

G. Are machinery and equipment kept clean?

H. Is equipment kept painted?

XI. Fire Protection

A. Do the operators know:

1. Whether there are fire hazards on their units?

2. What to do in case of fire?

(a) What extinguishers to use for each fire?

(b) How to send in an alarm?

(c) How to operate the extinguishers?

(d) What to do to the unit in case of fire?

B. Are fire extinguishers and fire blankets available at the units?

C. Are extinguishers free and accessible, or are they blocked from one or more directions?

D. Is unit arranged to permit rapid exit in case of fire?

E. Are explosive vapor detectors in working order?

F. Are no smoking rules rigidly observed?

G. Are any of the operators carrying "strike anywhere" matches?

Emphasis should also be given to general items and areas.

The form of the inspection report is flexible, but usually should include an introduction and a list of the safety items requiring attention. The items should be grouped under areas and projects for most effective presentation and discussion.

Safety-Meeting Details

The safety meeting should be set for a definite date each month, at a time most convenient to all concerned. Usually 4 p.m. is a good time since operators just going off shift may attend the meeting.

To aid in recording accurate minutes, parliamentary procedure should be followed during the course of the meeting, with the chairman presiding. A person wishing to speak should signal the chairman, gain his permission, and stand during the period for which he holds the floor. Full cooperation with this procedure is necessary for the conduction of business-like, interesting meetings.

Suggested chronological order of the meeting is as follows:

1. Discussion of inspection and project reports and discussion of any other pertinent safety matters.

2. Special first-aid or safety demonstrations.

3. Talk by member of group on a pertinent safety subject.

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MINERALIGHT Model SL 3660

Geologists' ultra-violet lamp for testing oil samples by fluorescence

- **Long wave, 3660 A.U., best for oil**
- **High intensity**
- **Weighs only 16 ounces**
- **110-volt A.C.**

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MINERALIGHT is one of the finest and most necessary field instruments a petroleum geologist can use. Every geologist can have one at the low price of $29.50, for 110-volt laboratory model. Complete field equipment, including carrying case, view box, and batteries, $23.50 additional. Weight 8 pounds. Available at oil well supply distributors. Write for catalog SL 8.

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Dealerships available in some localities

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POWER

THREADER

COMPACT — A complete, powerful machine, but so accurately built with the use of the best materials available that its total weight is only 1,000 pounds.

ACCURATE — Every thread is clean, perfect. Meets API standard. Counting flashes from red blinker light insures standard length threads.

FAST — The 44 is the ONLY threader that has the patented automatic chucking. This is the most important time saving feature on any threading machine. Check the time tables below, and remember these figures include chucking, unchucking, reaming, threading and cut-off.

Pipe Size	Floor to Floor
½"	16 sec.
¾"	16 sec.
1"	19 sec.
2"	27 sec.
2½"	35 sec.
3"	43 sec.
4"	76 sec.

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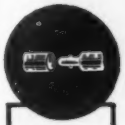


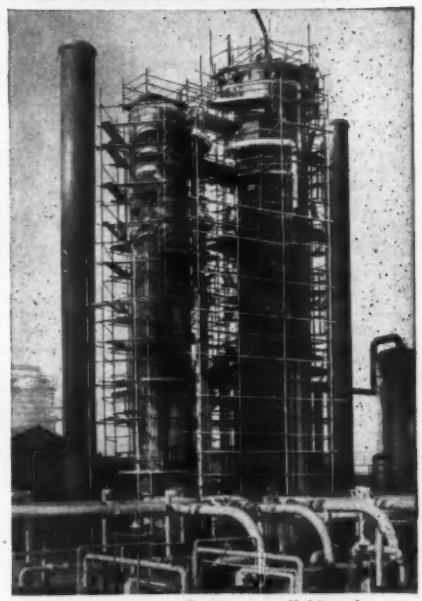
Tubelox tubes — several lengths

Standard coupler

Adjustable coupler

Bases — standard or caster

SAVES TIME AND LABOR ON OIL INDUSTRY JOBS



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- No limit on height, width or shape
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Economical!

- Only 4 basic parts
- Easy to erect and take down — even in restricted space
- Neat, compact, convenient
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- Dependable couplers
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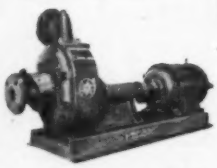
A typical Marlow Self-Priming Centrifugal engine driven model for portable applications.



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Powerful lift and force pumps for the heavy messy wastes that a centrifugal can't handle. Patented ball valve chambers are virtually clog-proof. Dependable for heavy duty dewatering, cleaning tank bottoms and cooling towers, for conditioning drilling mud, feeding slush pump, transferring water from wash pits and many other oil country tasks. Sizes 3- and 4-inch single and 4-inch double; 50, 100 and 150 GPM. Gasoline engine or electric motor driven. Skid base or steel or pneumatic wheels.

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The rugged Marlow walking Plunger Pump is fitted with metal plunger instead of diaphragm. With same basic features as the diaphragm pump, well suited to indefinitely sustained pumping for removing heavy sludge, residues, recirculation, for tank bottom disposal and other heavy jobs. Sizes 3- and 4-inch single; 60 to 90 GPM. Gasoline engine or electric driven, portable or stationary mounting.

This pump will lift from 20 feet below pump and discharge on total heads of up to 80 feet.

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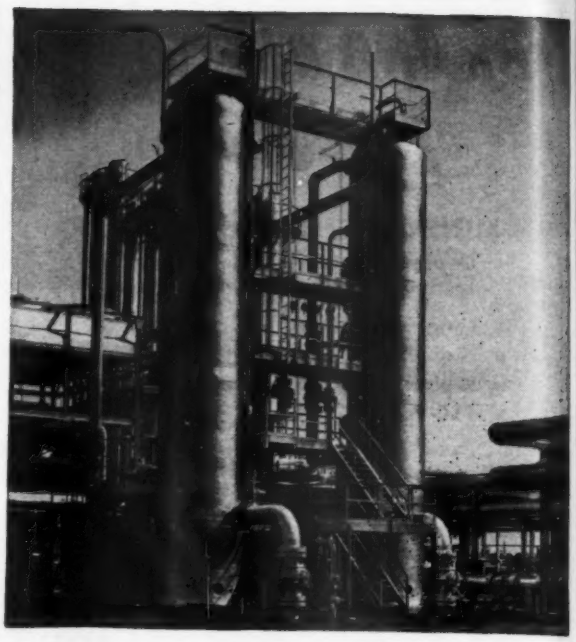

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This large modern plant has been in use since November, 1948, and, according to a report of the Panoma management at the end of a year, "has operated very satisfactorily."

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as well as two grades of Florite, which is a . . . .

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Your inquiry will be given careful attention.

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Well Spacing

(Continued from page 219)

push oil down to lower wells on the flanks of the structure.

In depletion-type fields, where the expansion of gas released from solution in the oil and gravity are the only sources of energy, the ultimate recovery may be only 15 to 25 per cent of the original oil, because when the gas is completely expanded, there is nothing more to displace the oil. Then, only gravity will operate, and, unless permeability and viscosity are especially favorable, gravity produces oil at such slow rates that wells usually cannot be pumped long enough to recover much additional oil above the 15 to 25 per cent.

Secondary recovery, or the addition of new energy by gas and water injection does provide means to recover oil left unrecovered by primary methods, but it is more efficient and cheaper to do one recovery job instead of two. After a pool has been inefficiently produced, there is usually permanent damage due to irregular water encroachment, increase in viscosity, etc.

Rate Control Necessary

To secure the extra benefits that may be possible in many fields with gas-cap drive and water drive, the production rate of most oil fields should be controlled to give the most efficient pressure decline, and the production should be taken from selected parts of the field, which will usually require unit operation. If gas is withdrawn in excessive amounts from the high part of a pool, it will not be available to push oil in the reservoir down to lower wells. If oil is withdrawn from a reservoir faster than an available water drive can push in, a prolific source of additional oil recovery is lost. If oil is withdrawn too rapidly from a field with active water drive, the water will encroach too fast in the more permeable layers of the reservoir and bypass oil in the less porous layers. It may be inefficient to produce much oil from wells close to the oil-water contact. In the instances just cited, pools that might have been gas-cap drive or water-drive pools, with possible recoveries of 35 to 70 per cent, are damaged so that less of the original oil may be recovered.

It is argued here that the size and importance of the additional reserves obtainable by the proper use of gas drive and water drive are not properly appreciated by some geologists and many others in the oil industry and that there has not been sufficient cooperation between many geologists and engineers toward the goal of greater recovery efficiency. Whenever the demands for closer well spacing result in field withdrawal rates that are too high, another opportunity for efficient water drive or gas-cap drive may be lost.

Programs for New Fields

During the first months of a new field, the important problem should not be the ultimate well spacing, as is often the case now, but the best recovery program. After plans are made for efficient use of reservoir energy, and the best field withdrawal rate determined, then the proper well spacing can be selected to produce the oil at efficient rates, and to supply available markets. This will surely require more unitization of pools and cooperation between operators and royalty owners, but the difference in many fields between possible recoveries of only 25 per cent and of 35 to 70 per cent of the original oil in place is so large that ways must be found to apply the more efficient methods.

Certainly, some geologists who insist on close well spacing can create situations where some fields are produced too rapidly, with the result that the available gas and water may not be efficiently used. Fields that might have recovered more oil may then approach depletion-type with only 15 to 25 per cent recovery. The advocates of close well spacing are then hindering the application of scientific methods to recover more oil.

The program that the engineers want for the best recovery efficiency in a field is one that will provide proper control of the pressure decline, so that all available gas and/or water can be properly used to recover oil. In a new field, they recommend that the first wells be drilled on a wide-spacing pattern designed to quickly furnish data about the oil pool, the size and limits of the reservoir, the geologic structure, character, and continuity of the reservoir formation, pressures, gas-oil ratios, fluid analyses, etc. With these data, the best economic program for the development and production of the pool can be chosen. This will include a well-spacing program adequate for the recovery methods to be used, adequate to meet the oil-production rate best for the entire pool, and adequate for the available economic markets.

If and when additional wells in closer spacing are economically justified to supply larger market demand, or shown to be necessary to properly drain the reservoir, they can always be drilled. On the other hand, after close spacing has caused the drilling of more wells than are really necessary, there has been economic waste that cannot be corrected, though the field may be otherwise efficiently operated.

It should be stated here that reservoir engineers do not advocate extremely wide spacing for oil wells, or claim that a small number of wells can economically deplete a sizable field. They recognize that time is always an important factor, and even though a small number of wells can ultimately deplete a large field, they would take too long, and a reasonable spacing program is necessary. Economic conditions, especially in shallow pools, may warrant more wells and closer spacing. Efficient recovery methods will favor slower rates of production and, hence, wider spacing.

The proper well-spacing program for any field is the best compromise between economic factors and efficient recovery methods. However, for the good of the industry and of all who use oil, compromises should not be made that will materially reduce the ultimate oil recovery. Wherever it is possible to apply methods that will materially increase recovery, they should be used, and more fields should be raised from the 15 to 25 per cent class to the 35 and 70 per cent groups.

Continuity of Reservoir Rock

Although most of this paper has discussed reservoir energy, the second subject on which some geologists and engineers disagree is the continuity of permeability in reservoir rocks. It was earlier stated that some geologists tend to expect irregularity and discontinuity of permeability in the producing formations in some areas. They assume that close well spacing is necessary, while engineers argue that field experience now shows that, generally, reservoir rocks have much more permeability continuity than might be expected.

The geologists base their opinion on the irregularities they have seen in some sandstone outcrops and in samples and cores from wells. They find some sands that are uniform and permeable, but many appear not to have continuous porosity and permeability. The sand grains vary greatly in size and sorting, the amount and kind of cementing material varies, shale laminations come and go, and bentonite-type clays occur in many sands. Also, many of the sandstone bodies themselves change abruptly in size and shape, as can be expected because in many places they were deposited as irregular sand bars, dunes, or stream deposits. In addition, the observations taken in the field with electric logs and with determinations of porosity and permeability in cores show great variations.

In spite of this apparent irregularity of individual sand layers, it is surprising that the behavior of the wells in almost all fields indicates that there is good communication in the reservoir rock and that oil, gas, and water move freely through the reservoir. There are very few fields where new wells drilled to old producing reservoirs do not have nearly the same bottom-hole pressures and gas-oil ratios as the surrounding wells. The sands in East Texas, Salt Creek, and many other large pools

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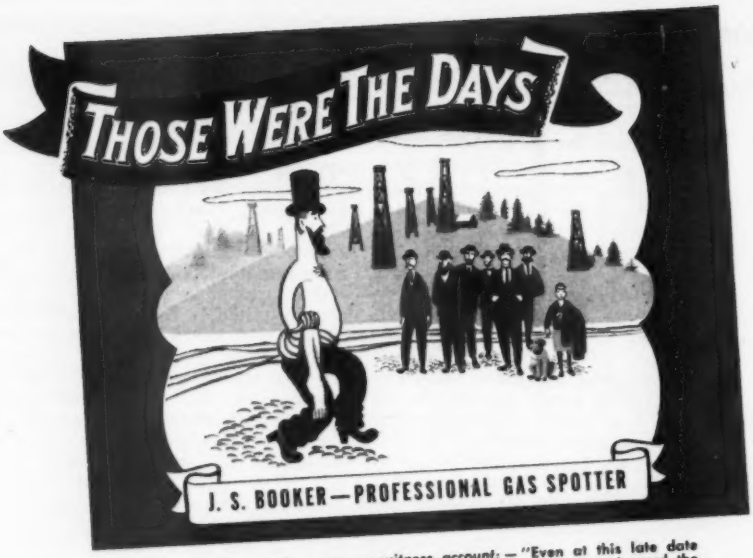

Condensed from an eye-witness account: — "Even at this late date (1865) there is little to guide the adventurous operator beyond the conceded existence of oil veins in the inferior rocks. A new profession of men, claiming to be gifted with extraordinary powers, has arisen in oildom — namely 'oil smellers' and 'gas spotters.' J. S. Booker, an Ohio man, claims to be able to spot gas. His particular virtue lies in the muscles at the back of his neck, which rise up and irritate him in the presence of natural gas. Booker's own story is that an attack of asthma left him in a sensitive state, so that when he passes over a vein of gas the electricity runs through his legs, up his spine, and knots the muscles of the neck. The practical people of oildom reason this way: 'If there be anything to gas-spotting, we may as well avail ourselves of it as not, for the diviner charges only from $25.00 to $100.00 for his services, and this is an inconsiderable item in the general expense, see we mean to bore anyhow'."

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are streaked with shale laminations and appear irregular, but the pressures and gas-oil ratios have equalized over the field.

It is true that in many fields faults do interrupt continuity and divide a reservoir into disconnected reservoirs, and in other fields many sand lenses are separated and not continuous. There are isolated cases, too, where a new well or a group of wells have found undrained areas with original pressures and gas-oil ratios in pools that might have been considered continuous. In such fields where discontinuity of the reservoir is demonstrated, everybody agrees that properly spaced wells must be drilled to drain separate parts of a reservoir, or, more correctly, separate reservoirs.

The disagreement between some geologists and some engineers on continuity of the reservoir rock comes when some geologists in the early part of a field's development insist that close spacing is necessary because the reservoir formation appears irregular and, therefore, is probably not continuously permeable. The engineers ask for wider spacing, at least until the performance of the wells in the field proves whether the reservoir rock has continuity. Then, if it is discontinuous, the engineer also will want more wells.

Tomlinson's Views

Many geologists in discussing the relation of well spacing to oil recovery refer to the papers and talks by Tomlinson, a prominent geologist and strong advocate of close well spacing. Tomlinson has operated for many years in southern Oklahoma, where sandstones of Pennsylvanian age produce at rather shallow depths in several large and prolific fields. Tomlinson says that he and others have drilled later infill wells in these old fields and have recovered economic reserves of oil that otherwise would have been lost. He also maintains that the behavior of wells in those fields proves that Cutler's Rule is correct, and he cannot agree with the engineers' newer recovery theories.

Tomlinson is referring mostly to Healdton pool, which was discovered in 1913 and rapidly drilled on a pattern of eight or nine wells on 40 acres or 5 to 4.4 acres per well. The wells were produced without restrictions and the early oil sold at distress prices or stored in large tank farms rapidly constructed near the field. The original pressure in the reservoir was soon dissipated.

Experience at Healdton

The writer of this paper is himself quite familiar with Healdton. He went there in 1919 and from 1919 to 1923 was actively concerned with the field's operation and located many infill wells. In 1921, Bartram and Roark published the first structure

map of Healdton field made after more than a year of detailed subsurface study. The writer has kept generally familiar with developments at Healdton, and has recently reviewed again the results of infill drilling and the production of various leases in the field.

At Healdton, oil is produced from three zones of Pennsylvanian sands in a shale and sandstone section 300 to 400 ft. thick. All the original wells penetrated the top sand zone, and some went through it to various depths in the shale and sandstone section. In some parts of the field, not enough wells were originally drilled to the second and third zones to adequately drain them, and the drilling of additional wells has been justified and profitable, and has increased the ultimate production of some leases.

However, on leases where the original wells penetrated all the sands on an adequate spacing pattern, the drilling of additional infill wells brought a temporary increase of production, but not any material increase in ultimate production. The decline curves of such leases went up at first, but then went down more rapidly than normal, and within 5 years were down again to, or below, the projection of their original decline curves. They will not produce enough additional oil to pay the cost of the extra wells.

The rate of production of such leases was stepped up by the extra wells and some oil was recovered faster, which can be an economic advantage, provided the faster rate does not cause reservoir damage and thereby reduce ultimate recovery. At Healdton, the faster rate could not damage the reservoir, because all the gas energy was dissipated 30 years ago and there is no natural water drive. Gravity is the only remaining force to bring oil into the wells, and at Healdton, gravity is working more effectively than in most Mid-Continent fields.

The sands at Healdton are quite porous and permeable and the structure is large and fairly steep. Oil will gravitate down to the lower parts of sand bodies, which will be the most prolific. Under these conditions the rate of production, which is controlled by the number of pumping wells, is entirely an economic problem. Additional infill wells on leases that already have adequately spaced wells, can be drilled only when the expenditures for the extra wells will result in greater savings in operating costs or in greater income due to temporarily higher prices for crude oil. Otherwise, it is an economic waste to drill more wells in a gravity-type field, because the ultimate production from the entire reservoir will not be materially increased. In other types of reservoirs with gas or water energy available, conditions are much different from those at Healdton, and production must be withdrawn at rates most efficient for each reservoir.

The writer is convinced that the behavior of Healdton field does not prove Tomlinson's arguments, and that it does fit the new and better concepts of reservoir energy. Rather than argue about what happened in an old field that was produced without proper control of the pressure decline, the geologists and engineers should be working together to do a much better job on the new fields that are being found.

If another Healdton is discovered in 1950, with ownership and lease conditions so that it can be developed and operated scientifically, it should yield its oil at considerably less cost, probably in a shorter time, and possibly even more oil than old Healdton. The original gas in the oil would not be rapidly dissipated, but conserved to prevent any increase in the viscosity of the oil, and to reduce lifting costs by flowing more oil. The gas could be reinjected into a gas cap, perhaps with supplemental gas from outside sources, to push oil downdip to lower wells faster than gravity works alone. A controlled water drive might be possible to push and float oil updip.

The wells would be strategically located to efficiently recover the oil on a planned program and additional wells could be drilled as changing conditions made them necessary. The well spacing would be fairly wide with much fewer wells on top where the gas cap would form, and more wells on the flanks where the recovery methods concentrated the oil. If the sands proved to be so irregular that the original spacing pattern was inadequate to drain them, additional wells could be added. Under this program, the oil would be recovered in one operation, and not in two operations, primary followed by secondary recovery. Such a modern recovery program should recover the oil with lower drilling and operating costs and over a shorter period of time; and, if a water-drive is possible, even more of the original oil should be recovered.

Conclusions

1. Since the oil supply in the United States is not unlimited, it is imperative that every oil field be produced in the most efficient manner, to recover the largest possible percentage of the original oil in the ground, at a low cost, and within a reasonable time. While more and more fields are being developed and operated by the best scientific methods, there are still entirely too many oil pools which are not produced efficiently to secure the best recoveries. Not all fields can be improved by the new methods. Some have such efficient natural water

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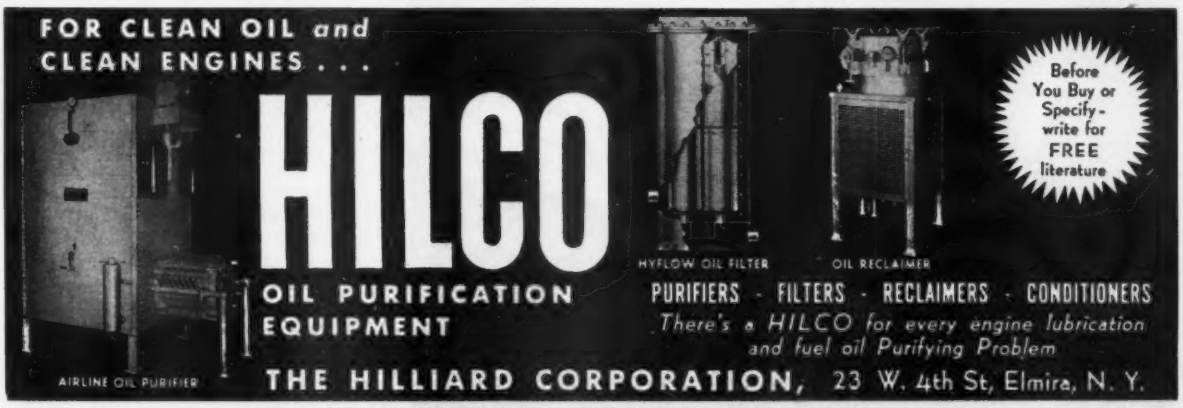
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drives that high recoveries are obtained with little engineering control. In other fields, gas-cap and water-drive methods are not applicable. However, there are many pools that might be improved by modern methods, but will yield only 15 to 25 per cent of the original oil because operating conditions prevent use of gas-cap drive or water drive that might increase recoveries to 35 and 70 per cent.

2. One reason why more concerted effort is not being made to realize greater recovery efficiency has been the intensity of arguments over proper well spacing, which is only a minor part of the problem, but appears to be of great importance to some. This well-spacing argument has actually worked against increased recoveries in some fields, where close well spacing has been obtained by its advocates. In a pool which has many wells, the large investment in drilling tends to bring high individual well allowables that, together, result in excessive total field withdrawals. If the oil and gas are taken out so fast that gas-cap or water-drive energy cannot be used effectively, the field may approach depletion type with recovery of only 15 to 25 per cent.

3. Much of the industry disagreement about well spacing is between engineers who have developed new theories about reservoir conditions, and some geologists who are not yet willing to accept the engineers' new theories. This disagreement should be rapidly settled, and the two groups of scientists should work together to increase recovery efficiency. It is argued here that, although few agreed with the reservoir engineers' new theories at first, and some of the theories may not have been correct, the engineers are now "over the hump" on most of their basic theories. With an accumulating mass of evidence, they are steadily convincing more people in the industry, and gradually will gain general acceptance. The geologists had the same experience when they sold their anticlinal theory to the industry 30 to 40 years ago.

4. Some geologists can be criticized for this disagreement on well spacing because they have neglected to keep fully informed on the progress made by reservoir engineers in their studies of reservoir mechanics, and therefore, may be arguing on a subject about which they are not fully informed. Some engineers can be criticized because they have not made greater efforts to sell other groups in the industry regarding their new conclusions. They have been busy working on their own problems, have presented papers mostly in their own engineering publications, and have assumed that others would automatically agree with them. This can be corrected soon, if all geologists who participate in the selection of recovery and well-spacing programs will take the time and effort to understand the reservoir engineers' story, and if the engineers will better present their theories in language that geologists and other nonengineers will read and understand — that means without complicated mathematical equations and graphs.

5. Even when the geologists and engineers do agree, it will still be necessary to educate others in the oil industry, the royalty owners, and the general public that the vast additional reserves, measured by the difference in many fields between 25 and 35 or even 70 per cent of the original oil, are worth much greater and concerted efforts to recover them. Companies and individuals must become willing to accept the inconveniences of unitization, of scientifically controlled rates of pressure decline, and sometimes lower field production rates, which bring lower current cash incomes.

6. To recover more oil ultimately from every field, the industry must learn that, instead of rushing ahead to drill closely spaced wells around a new discovery well and then producing at maximum rates, it is better for all concerned to proceed so that the most efficient program for the

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STATEMENT OF CONDITION

June 30, 1950

RESOURCES

Cash and Due from Banks	$52,664,693.51	
U. S. Government Securities	74,367,118.61	
Other Bonds and Warrants	5,302,985.91	$132,334,798.03
Loans and Discounts		36,109,347.89
Overdrafts		27,922.75
Income Receivable Accrued		382,353.50
Prepaid Expenses		62,152.22
Stock in Federal Reserve Bank		180,000.00
Bank Premises		2,000,000.00
Customers' Liability Under Acceptances		34,254.00
TOTAL		$171,130,828.39

LIABILITIES

Deposits		$158,913,613.45
Acceptances Executed		34,254.00
Income Collected, Not Earned		160,767.67
Reserve for Taxes, Interest, etc.		763,510.74
Dividends Declared*		150,000.00
Capital—Common	$3,000,000.00	
Surplus	3,000,000.00	
Undivided Profits and Reserves	5,108,682.53	11,108,682.53
TOTAL		$171,130,828.39

*Payable $75,000.00 July 14, 1950, $75,000.00 October 13, 1950

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entire field can be determined as soon as possible, and then to drill and produce according to that program. This will mean that the total field production will be limited to an efficient rate, and the well-spacing program will be designed to meet, but not exceed that rate, and adequately to drain the reservoir.

7. Later, if economic conditions justify higher production rates, or if the behavior of the field proves that more wells or differently spaced wells are needed to adequately drain the reservoir, the additional wells on closer spacing can be drilled. The failure to drill them sooner will not have wasted any energy or lost any reserves. The drilling of unnecessary wells is a direct economic waste, and also makes it easier to produce fields too rapidly and inefficiently.

Mud Materials as Tools

(Continued from page 221)

needed samples and tests to obtain the desired geological information, and protect the zones containing hydrocarbons so that the oil or gas may be efficiently produced. A single bore hole penetrates numerous formations, each having particular properties as to chemical composition, physical state, and structural conditions. A drilling fluid to accomplish its purpose must be such that its physical and chemical properties can be altered as needed to handle the various formation conditions encountered.

We are fortunate in having a sufficient number of tools presently available to handle most of the problems that have been experienced. Drilling fluids can be prepared to meet any reasonable specification as to physical properties, using as a base fresh water, sea water, or saturated salt water. Sodium silicate brine muds are used where it is desired to prevent the hydrous disintegration and swelling of bentonitic shales commonly found in heaving-shale zones. Oil-base muds, with a wide range of physical properties, meet the requirement for nonaqueous drilling fluids.

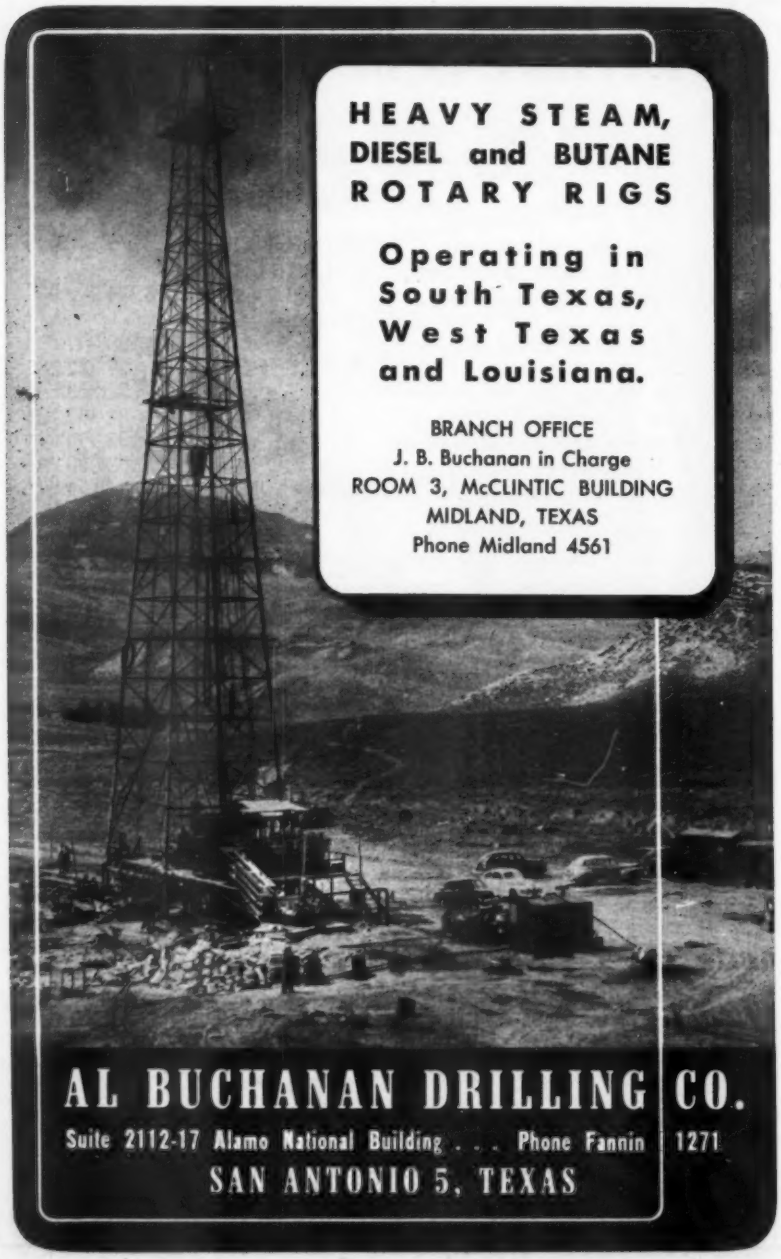
The practice of preplanning the mud program for the entire well is receiving widespread acceptance because of the economies in drilling time and costs it has effected. This allows the selection of the type of mud best suited for each stage of the drilling operation, keeping in mind the effect upon the open hole of the changes in types of mud contemplated.

As an example of the foregoing, in many areas holes can be drilled several thousand feet below surface casing with an untreated natural mud with little or no attention being given to the properties of the mud. Such holes often become water soaked, enlarged, and the sand sections plastered with a thick filter cake. Under such conditions it is not uncommon to experience trouble when chemical treating is started to condition the drilling fluid to handle the deeper formations. The addition of chemicals may strip the hole of the thick filter cake, resulting in tight spots that have to be reamed, and cause sloughing of the water soaked shale sections. This can be prevented by treating the mud lightly with chemical dispersants, and adding small amounts of colloidal clay as needed to maintain good mud properties at all times while drililng below surface casing.

Such a program is not expensive, as very little in the way of mud materials is needed. This slight cost is more than offset by increased drilling rate and prevention of lost time due to reaming. In a number of fields, a severe lost- circulation problem has been prevented by drilling the upper hole with mud that protected exposed formations with a thin impervious mud sheath. Advantages of using a good mud for upper-hole drilling cannot be overemphasized, because it simplifies the control and reduces the cost of maintaining the drilling fluid during deeper drilling.

Red-Lime Muds

During the past several years phosphate-treated muds have been replaced to a considerable extent by caustic-quebracho-lime muds. There



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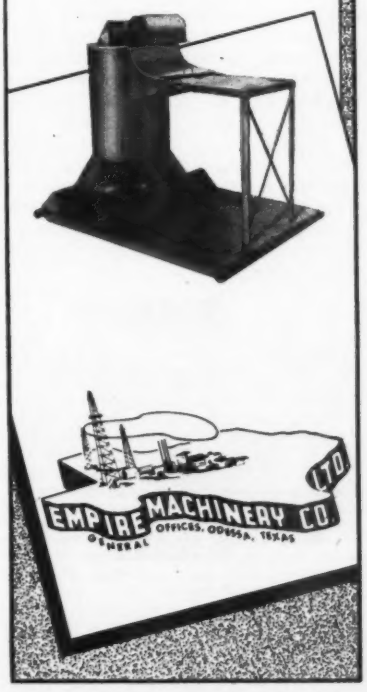

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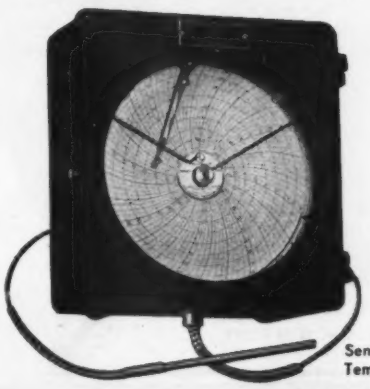

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now appears to be a slight reversal in this trend. Recent work has shown the use of glassy phosphates, such as sodium tetraphosphate in combination with an organic dispersant such as quebracho, results in simplified control and lower mud costs for drilling wells of moderate depth. Small amounts of phosphates can be used to advantage in connection with a caustic-quebracho treatment for upper-hole drilling, and this will not seriously complicate the later conversion to a lime mud.

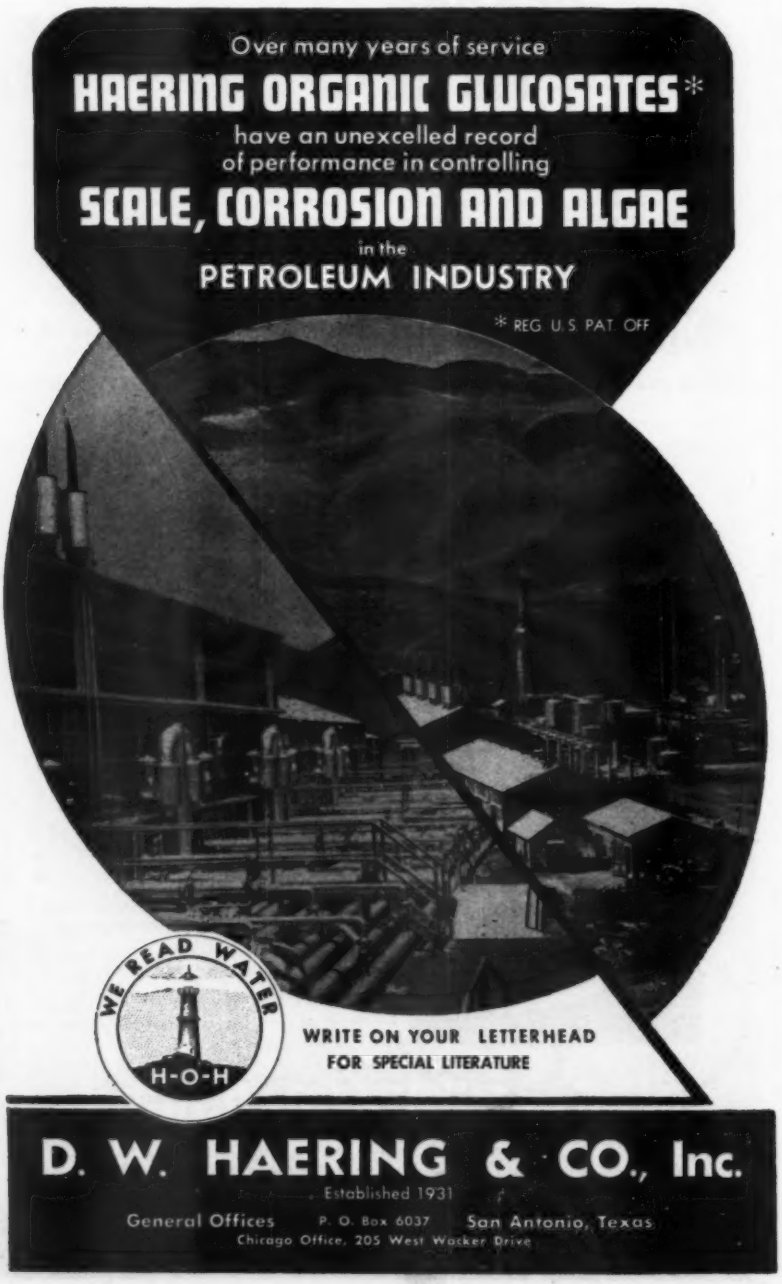
The use of caustic-quebracho-lime treated muds (red-lime mud) is not new, but increased knowledge of the behavior of this type of mud has made it the most valuable tool of the mud engineer. Red-lime muds have a large tolerance for colloidal solids, are resistant to formation contaminants, and can be maintained at any desired weight between 10.5 and 20 lb. per gallon. This type of mud is intended for deep drilling where abnormal pressures are expected, or where contamination makes mud control troublesome. It is not suited for shallow drilling because the minimum maintenance cost is relatively high.

In the past some red-lime muds have been difficult to control, but improved methods of testing have largely eliminated this objection. The method for determining the approximate lime content of mud proposed by P. E. Chaney of Sun Oil Co., has contributed much to simplify the control of lime mud. Field experience has shown that stable lime muds can be maintained by controlling the filtrate alkalinity, lime concentration, and content of organic dispersant within definite ranges of concentration. The character of the shale in the formation being drilled influences the concentration of lime that is required to keep the mud stable, and the amount that must be added to maintain that concentration. A typical red-lime mud contains approximately 3 lb. per barrel caustic, 2 lb. per barrel quebracho, and 8 lb. per barrel lime. At present, there is a trend toward carrying higher lime concentrations (in some cases in excess of 20 lb. per barrel), and reports indicate increased stability. The filtration properties of red-lime mud are controlled with gelatinized starch, and experience has indicated the desirability of maintaining the filtration test below 6 cc.

Oil-Emulsion Muds

Oil-emulsion muds are gaining recognition as aids to drilling and improved completions. Oil containing an oil-in-water type of emulsifying agent is added to any type of water-base mud to prepare an oil-emulsion mud. The amount of oil added varies from 5 to 20 per cent by volume, depending upon the intended use. The properties and the behavior of the resulting mud are similar to those of the base mud to which the oil is added. The emulsified oil improves the lubricating properties of the mud, increases the rate of drilling of most formations, reduces the water loss of the mud, and often results in better completions.

The trend in mud is to provide stable drilling fluids that will aid the drilling operation by speeding up the rate of penetration, prevent hole trouble, and allow the maximum recovery of the oil from the zones penetrated.



BOOKS

REVIEW OF THE ESTONIAN OIL SHALE INDUSTRY, WITH A BRIEF ACCOUNT OF OIL SHALE DEVELOPMENT IN THE UNITED STATES. By Peter O. Krumin. Published in Ohio State University Engineering Experiment Station, Columbus. 126 pp. $1.

This is a thorough treatise on the Estonian oil-shale industry, containing as it does some new data fast becoming obscured by the iron curtain, and some data not reviewed in the American or British papers, such as high-temperature carbonization of oil shale for production of city gas. It is the second portion of the work which will probably be of most interest to American readers, as it is here the author reviews development in the United States. The resources, production, recent developments, experimental mines, retorting, refining, and cooperative research are explored.

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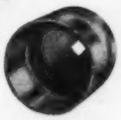

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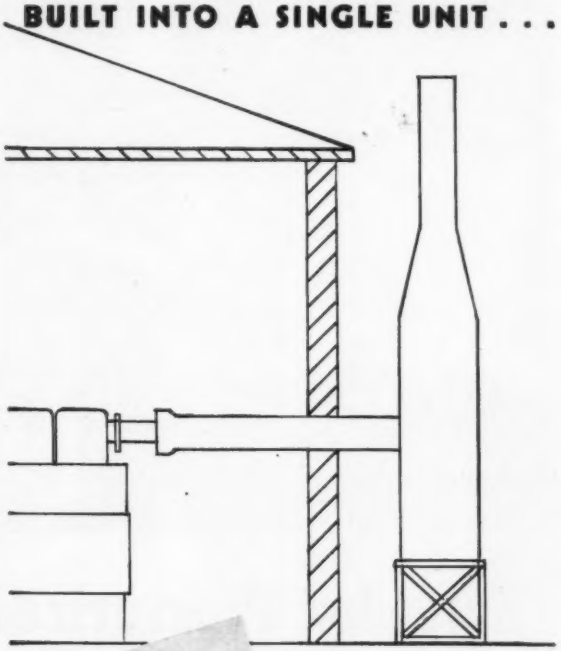

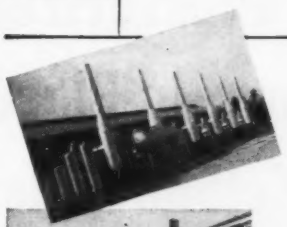

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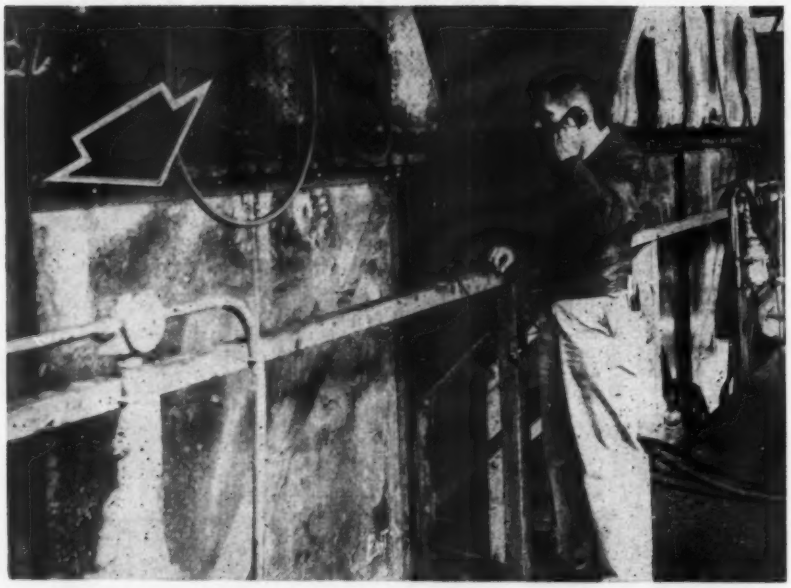

Here are the extended pressurized "houses" used in filter repair. The metal walls are bolted to base and hood of each filter, forming an air-tight working space for repair operations. Air, water and oxygen-acetylene hoses and telephone and light cables are run through rubber grommets in port openings in the hoods. Before entering the enclosure, workmen telephone inside, and all hot work is suspended before the door is opened.

Extended Pressurized Safety Hood Allows In-Place Repair Of Ketone Filters

by Parker C. Folse and Homer T. Fort*

A METHOD for using welding, burning, or soldering in the repair of ketone filters without their removal or loss of unit stream time has been developed at the Beaumont refinery of Magnolia Petroleum Co.

The problem of ketone-filter repair has always been a difficult one in the average refinery because of the high flammability of methyl ethyl ketone. In the case of the Beaumont refinery this condition was aggravated by the closeness of its ketone unit to other operating units. Maintenance of safety factors therefore required the removal of the filters to the plant's machine shop. In addition to bearing an inherent hazard, this procedure also meant high costs in the form of materials handling as well as delays in returning to full operating efficiency. With lubricating oil involved, this last factor assumed considerable significance.

*Refining Division, Magnolia Petroleum Co., Beaumont.

Several months ago the refinery was faced with the necessity of repairing seven of the unit's eight filters, three of them immediately, because the brass screens had corroded and deteriorated to an extent demanding renewal. The unit's production, if not interrupted completely, would assuredly be greatly hampered if a removal-repair-return program of maintenance were put into effect.

The proposal that led to solution of this problem was put forward by E. R. Kehrer, general foreman of the refinery's machine shop. It was his suggestion that the filters needing repair be "housed in" while keeping a positive pressure on the inclosure during periods when "hot work" was in progress.

Safety division and processing personnel were consulted and permission was given to proceed with the work. Normal procedures were used in making the filters ready for repairs—oil lines to and from the filters were either blinded or disconnected, and

Left: Screens are soldered in place without removal of the ketone filter units. Workmen inside the hood assembly receive fresh air through a positive pressure system. Right: A welding machine employing argon was found most satisfactory for screen repair. This method eliminated finishing work and reduced down time on the filter units.

the filter was washed with hot water until it was free of oil and gases.

Extraordinary safety precautions were planned in advance. Additional fire-extinguishing equipment was placed at the location, and a safety inspector equipped with a gas-testing device was scheduled to be present at all times when work was in progress. Operators were alerted to stop all work in event of trouble.

Design of Safety Houses (Hoods)

Two houses were used simultaneously after being built around the filters. They were built with a structural angle frame covered with galvanized sheet metal and steel strips. The sheet metal was fastened to the framing by bolts through steel strips. The framing was made in four sections with doors on each of two sides. These "houses" were bolted to the filter hood and base with gasket material used between the metal surfaces. All sections were sealed to make the house airtight.

After the filter hood is disconnected it is raised 6 ft. by an overhead crane, and the wall sections are assembled on the base. Thus the filter hood serves as the top of the airtight housing unit.

A further defense against the building up of a dangerous gas concentration came through providing a positive pressure on the inside with fresh air supplied through air ducts by blowers. A damper was installed in the inlet ducts and connected to the doors with steel wire. The purpose of the wires was to close the damper when the door was opened. This eliminated loss of air through an open door and consequent reduction in air supply to any of the other houses.

Utilities were provided on the inside of the houses by running all air and water hoses, light and telephone cables, and oxygen-acetylene hose through rubber grommets in port openings on the hood.

Protection against a rupture of glass on port openings of adjacent filters, then in operation, was provided by the construction of walls approximately 6 ft. in height and made of galvanized sheet metal.

In operation, personnel doing mechanical work wore standard safety equipment, including goggles and knee pads. Rubber pads from the locker room were converted into "sitting pads" for soldering and grinding operations. All hot work was stopped when it became necessary to open the doors for entering or leaving.

A complete stoppage of work was ordered during the washing of an adjacent filter.

Repair Methods

The actual work of repair on a filter began with the removal of brass screens by chisels, and removal of the solder which held the screens to the drums, by melting with an oxygen-acetylene torch. The brass screens were replaced with 18-8 stainless steel, type 304 screens, 8 mesh and 0.047 in. in diameter. Their approximate size was 8 by 1 ft. The new screens were then soldered in place, one panel at a time, with soft solder melted with oxygen-acetylene torches.

On another filter screens were removed in the same manner but the installation of the new screens differed somewhat from the first. In place of soldering the screens to the drums, stainless steel, type 304, angles were welded to the drum with 25-20 stainless rod. This was an improvement over soldering but required considerable finishing with an abrasive wheel. After the finishing work was completed, the angles were bent over the edge of the screens.

On still another filter angles were spot-welded in place with welding machine using argon for shielding. This method eliminated the finishing work and has saved on down time for the filter-repair job.

It is believed that the development of the hood method for facilitating repair of ketone filters is an important contribution to refinery safety and will be of considerable value in ketone-unit maintenance.

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QUESTIONS on TECHNOLOGY

by W. L. Nelson
Consulting Engineer

Gasoline Reforming by Platforming

Will you please summarize the new process of Platforming for us? R.G.M.

This new Universal Oil Products Co. process for "upgrading" naphtha stocks catalytically, can be applied to straightrun gasolines, thermally cracked gasoline, or mixtures.

Little has been reported regarding the catalyst except that it contains platinum (hence the name "Platforming"), and that the platinum can be completely recovered from the catalyst.

The catalyst is arranged in a series (three) of fixed-bed reactors. No provision is necessary for catalyst regeneration because little coke is deposited.

Charge to the process is fed first to a prefractionator where the actual feed to the first reactor is made as a side product to insure uniformity. This select feed is heated by exchangers and a fired heater to about 850°-900° F. It is mixed with a hydrogen-rich recycle gas heated to the same temperature. This mixture flows through a first-stage reactor, through an intermediate reheat furnace (850°-900° F. outlet) to a second reactor and through a final reheat furnace to the third reactor. The effluent from the final reactor flows through reboilers and exchangers and finally flashes into a separator at 100° F. and 650 psig.

The separator liquid is fed to a fractionator where the platformate is stabilized to the desired vapor pressure. A portion of the separator gas is compressed, heated, and mixed with the fresh feed to the first reactor. The remaining separator gas is sent to fuel along with gas from the stabilizer. These gases are almost sufficient to supply the fuel needs of the unit.

Four principal reactions occur in Platforming. These are (1) dehydrogenation of naphthenes to aromatics, (2) hydrocracking of high-molecular-weight paraffins to lower-molecular-weight paraffins, (3) isomerization of both paraffins and naphthenes, and (4) desulfurization of sulfur compounds to produce hydrogen sulfide. All these reactions are in the direction of octane-number improvement. The over-all reaction is endothermic; this effect decreases from the first reactor to the third.

The hydrogen in the recycle gas (about 85 per cent hydrogen) is produced by the aromatization reaction and makes the process nonregenerative by preventing coke deposition.

Sulfur removal has ranged from 88-99 per cent to produce a total sulfur content in the finished product of only 0.002 and 0.005 per cent. Initial sulfur content appears to have little effect on the amount of sulfur that remains.

Platformate exhibits good storage stability, requiring inhibitor only to effect retention of tetraethyl lead in solution. The material has an induction period of more than 1,150 minutes and a 5-hour accelerated gum of less than 1 mg. per 100 ml. It is inherently stable because it is nonolefinic.

The response of platformate to tetraethyl lead compares favorably with that of straightrun gasoline in spite of its high octane number.

TABLE 2—OPERATING COSTS FOR A 1,500-2,000-BBL. PER STREAM DAY PLATFORMING UNIT*

	Cents per bbl. reactor charge
Operating labor	4-5
Maintenance	3-5
Taxes and insurance	4-5
Utilities	4-5
Catalyst	<10
Royalty (escalator)	7
Total	30-37

*Installed cost, about $700,000.

TABLE 1—PERFORMANCE DATA—COMMERCIAL REFORMING UNIT

		730			720	
Avg. reactor press., psig. ..						
Avg. reactor temp., °F.		880			890	
	Reactor charge	Stab. Platformate	10 lb. R.v.p. Platformate	Reactor charge	Stab. Platformate	10 lb. R.v.p. Platformate
Yields (vol. % of chg.)	....	94.4	97.3	....	92.6	97.1
Inspections:						
A.P.I. gravity	59.5	60.4	61.7	58.1	57.4	59.7
R.v.p.	2.5	8.1	10.0	2.0	6.9	10.0
Per cent sulfur	0.031	0.003	....	0.08	0.0019	....
Octane numbers:						
Research, clear	51.9	79.1	79.9	52.5	81.3	81.9
Research + 3 cc.	71.4	93.1	93.6	70.2	93.9	94.7
A.S.T.M., clear	48.3	75.8	76.7	48.9	75.5	76.1
A.S.T.M. + 3 cc.	70.2	87.6	88.3	68.5	87.4	88.2
A.S.T.M. distillation:						
I.b.p.	160	103	....	166	110	....
10	196	148	....	203	155	....
30	217	184	....	225	195	....
50	239	214	....	248	225	....
70	266	246	....	273	260	....
90	304	297	....	309	308	....
E.p.	340	350	....	355	363	....

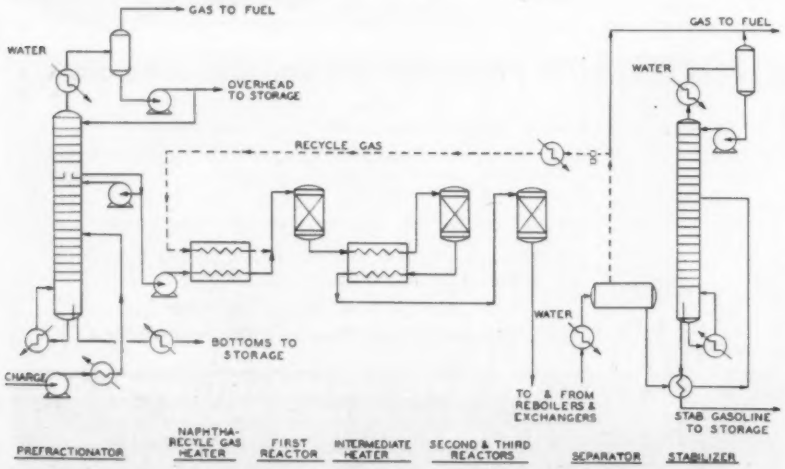

Fig. 1—Simplified flow diagram of Platforming operation.

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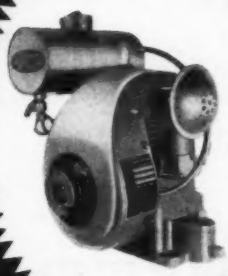

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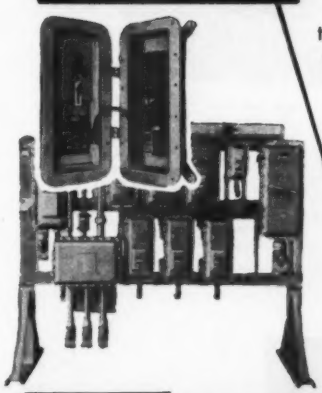

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XUM

Engineers Confirm in the Field the Strength and Accuracy Technical Editors Found in Gurley Aluminum Alloy Transits

Gurley Instruments

An article describing the advantages of aluminum construction of Gurley instruments where accuracy, strength, lightness and freedom from vibration are essential.

Probably the controlling incentive in the application of aluminum alloys to surveying instrument construction has been the prospect of weight reduction. Consider the labor to be saved by a surveying party which has to carry these instruments about, day after day, often over rough country, when the weight can be reduced by at least

metals and structural metals been so effectively and economically combined. A further result of the use of aluminum alloys through this method of manufacture is a decrease in the number of parts. Minor assemblies have been combined into single parts, permitting more accurate manufacture and insuring a permanence of adjustment of these parts in service. A feature is doubly true,

aluminum alloys have shown, not only greater structural strength and durability, but greater stability under conditions which induce vibration. That this should be so is readily apparent, since the light weight greatly reduces the momentum of the instrument and consequently the amplitude of vibration.

Gurley transits constructed of the light alloy metals have been used on all kinds of work, meeting successfully the requirements of durability

Aluminum Used Successfully in Precision Instruments

A PICTORIAL STORY

Requirements of accuracy during a long service life are controlling factors in selection of materials for engineering and surveying instruments.

● IN THE MANUFACTURE of precision instruments, the selection and careful processing of materials is of prime importance. Accuracy as well as long service life with a minimum of adjustment and repair are the quality standards that must be met, and to meet them, astute materials engineering coupled with expert workmanship are required. Perhaps no better example of the combination of these two factors can be found than at W. & L. E. Gurley, Troy, N. Y., where precision instruments are produced not only for engineering and surveying, but also for other fields such as meteorology and aeronautics.

machining; (4) good ductility; (5) relatively good corrosion resistance, especially in sulfur atmospheres; and (6) does not distort nor "grow" with age. The aluminum alloys most used at present are 145W, 61ST, 356 and 13. A thorough test program in-

sures against any differences in accuracy within a temperature range of —80 F and +165 F.

The accompanying pictures illustrate a number of the steps involved in the production of various parts making up the transit.

Combining durability and lightness with precision for surveying transits

by David W. Veit
Editor, The Gurley Magazine

MANY surveying instruments built by W. & L. E. Gurley, Troy, N. Y., are accurate within one second of arc. If projected, this represents a maximum error of ½ inch in a mile.

However, precision is not the only requirement of these instruments. At least three other major factors influence the design and choice of materials for this type of equipment.

In the first place, a surveyor's transit must not only be accurate, but must maintain its accuracy over an indefinite period of years despite all sorts of weather and climatic conditions —heat, sub-zero temperatures, dampness, dust or salt-saturated atmospheres.

Second, it must withstand rough usage. This is outdoor equipment subjected to impact and abrasion.

The third requirement — no less important than the other

desirable features has been by turning to aluminum for a major group of components. And since aluminum has been picked to fulfill the physical and mechanical needs of these surveyor's transits, it is not surprising that several of the most important parts are being produced most economically by die casting.

Die cast aluminum parts include the truss standard, telescope housing and leveling spider, as well as end targets and

fers additional weight saving advantage, even as compared with sand cast aluminum, due to the thin, uniform wall section which is practical by die casting.

This pioneering instrument builder has used aluminum die castings wherever possible; this is one of the few production short cuts possible in a manufacturing operation characterized by extensive machining, finishing and assembling operations within close tolerances.

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FROM A COMBAT ENGINEER IN WORLD WAR II:

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Variations in Field Relative Permeability Curves

THE pressure and production data from a reservoir can be used to construct a field relative-permeability curve. For this purpose the following equations are used:

$$\frac{k_g}{k_o} = (R - r)\frac{\mu_g}{\mu_o}\frac{v}{\beta} \quad (1)$$

$$S_o = \left(1 - \frac{\Delta N}{N}\right)\frac{\beta}{\beta_o} - (1 - S_w) \quad (2)$$

where the nomenclature is as given below. This calculation was discussed in detail in No. 341.

In general, but particularly for a solution-gas-drive reservoir, this technique will yield a curve of the nature shown in Fig. 1 which is presumed to be a portion of the entire relationship shown by dotted lines. The field curve therefore has usefulness by extrapolating it as indicated in a linear fashion and using the extrapolated points to back calculate in the above equations. In addition the field curve can be used to infer types of reservoir control.

The field calculated curve will reflect any inaccuracies in estimated oil in place, N, because this value appears in Equation 2. The effect of an error in N is to raise the k_g/k_o curve if the estimated value is high and to lower it if the estimated value is low. This is shown in Fig. 2. This variation suggests the possibility of setting limits for estimates of N by comparing the field curves so calculated with laboratory curves or with other field curves. An inaccuracy in the estimated value of connate-water saturation will also tend to compress or expand the calculated curve.

The field relative-permeability curve cannot be extrapolated across limits representing changes in operational procedure. In this respect it is very similar to a production-decline curve where a change in operating procedure is invoked. The outstanding example of such a change would be the shutting in of high-gas-oil-ratio wells in a reservoir. The value of k_g/k_o calculated from Equation 1 depends directly upon the producing gas-oil ratio. If, at a certain time, high-gas-oil-ratio wells are shut in the effect is to immediately lower the calculated k_g/k_o, but the calculated value of reservoir oil saturation remains unchanged. The result is as shown on Fig. 3, and if the gas-oil-ratio values can be controlled after the change to yield more efficient production, then the slope of the field relative-permeability curve must be lower after shut in than before.

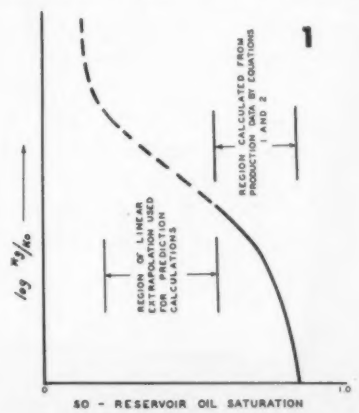
In effect the field-permeability curve becomes a criterion of performance just as do the production or pressure decline curves. As a matter of fact, the field relative-permeability curve combines both the production and pressure declines in Equations 1 and 2.

If a calculation were made for an ideal homogeneous condition the results would reflect only the properties of the reservoir rock, and the field curve would then coincide with a laboratory-determined curve. Actually, however, the curve calculated from field data is a reflection not only of the reservoir rock characteristics but also of the operating conditions.

In any reservoir where an external force is acting to keep the gas-oil ratio low, the indicated slope of the field relative-permeability curve will also be low. A partial water drive on a reservoir, might, for example, lower the slope of the calculated curve even below that of the ideal laboratory curve. Controlled gravity drainage might also be shown in the same manner on a field curve. Thus, the calculated curve also becomes an indicator of reservoir mechanics provided the other variations can be eliminated.

Nomenclature

- k_g/k_o = relative permeability ratio, gas to oil
- R = producing gas-oil ratio, standard cubic feet per barrel
- r = solution gas-oil ratio, standard cubic feet per barrel
- μ_g/μ_o = viscosity ratio, gas to oil
- v = barrels reservoir space per standard cubic feet of gas
- β = formation volume factor
- β_o = original formation volume factor
- S_o = fractional reservoir oil saturation
- S_w = fractional reservoir water saturation
- $\Delta N/N$ = fractional production of original stock-tank oil in place


1
REGION CALCULATED FROM PRODUCTION DATA BY EQUATIONS 1 AND 2
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log Kg/Ko
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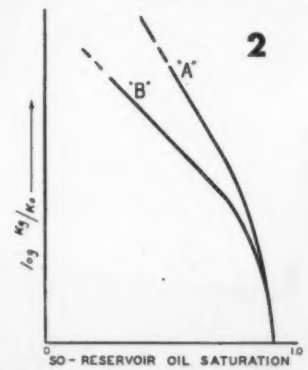

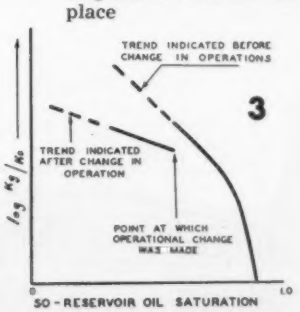

Series by Dr. John C. Calhoun, Jr., Chairman, Petroleum Engineering School, University of Oklahoma

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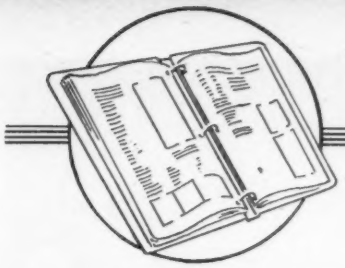

THE REFINER'S notebook

Metered Control Systems

REFERENCE has been made at various times to interlocking control, also termed metered or cascade control. The interlocking system, or "interconnected control instrumentation" as it is sometimes called, employs a master instrument (which may be a transmitter or a controller with proportional or proportional - plus - reset characteristics) to convert changes in the primary or master variable into air pressure transmitted to a secondary instrument. The set or control point of the secondary controller is shifted, by means of a remote index setting mechanism employing an auxiliary bellows according to the changes in output air pressure from the primary instrument. At the same time changes in the value of the secondary variable (usually flow) are transmitted to the secondary controller which then acts to position the control valve regulating the secondary variable.

Interlocking control. — Metered control and ratio control may appear to be similar at first glance, but note the difference between the two methods. No fixed ratio exists between the primary and secondary variables in metered control, as it does in ratio control. In cascade or interlocking systems as distinguished from ratio systems, the magnitude of the secondary variable is changed while the master variable is held at a given set point.

Suppose we consider the case where it is necessary to control the flow of water to a condenser and that this is done by means of a pressure controller. (This example, where all but a very small amount of the overhead is condensed, was noted in the Refiner's Notebook, March 23, 1950.) Close control of condenser water is required but accurate positioning of the control valve is difficult due to fluctuations on the supply side. Water pressure may change suddenly and over a wide range. One solution to the problem would be the installation of a valve positioner. For close control, in this special case, a better solution is obtained through installation of a flow controller reset by the master pressure controller. A change in the rate of water flow is measured by an orifice meter in the water line, and transmitted to the flow controller. The latter then acts to correct for this load change by repositioning the control valve in the water line before any upset has occurred in the process.

Metering from liquid level.—In discussing level and flow control a process was considered where the flow from the reboiler or reflux drum of a column was the feed to a second column. This case, encountered often in refinery processing, could be handled through direct positioning of a valve by a level controller, if rate of feed to the second column were not critical. Where rate of feed is critical additional surge capacity must be provided or the interconnected control system shown in Fig. 1 (left) might be used. Here correction is made for pressure changes on the reflux drum which might result in flow surges and serious upset in the fractioning system. The level controller by itself would measure and control only changes in the liquid level. With the interlocked system stable flow is obtained without costly increase in size of the reflux drum. Upsets with resulting off-specification product are minimized.

Other combination systems.—Under certain conditions the combination system of Fig. 1 (right) may be applied, using a temperature controller to reset a flow ratio controller through which feed is proportioned to overhead product. A number of variations of this more complex system are possible. The temperature controller might be used to reset a flow controller regulating a valve on steam to the reboiler, with reflux proportioned to feed through an interconnecting relay. In place of the differential temperature controller, the primary instrument could be a differential vapor pressure transmitter.[1] The use of a process control spectrometer to reset a flow controller is also possible.

1. Tivy, V. V., "Automatic Control of Fractionating Towers," The Oil and Gas Journal, Nov. 25, 1948, p. 85.

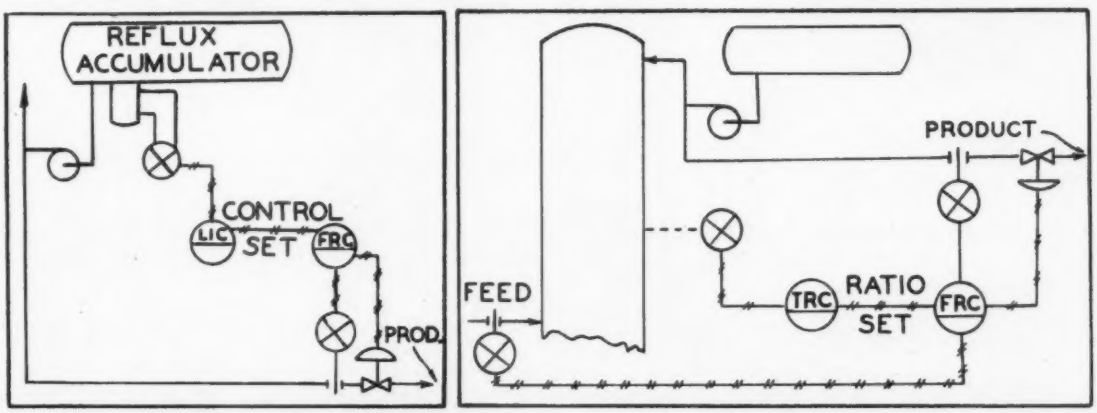

Fig. 1—Examples of interconnected control. Installations with primary and secondary transmitters, as shown here, might be specified under certain conditions.

No. 30 in current series. The Refiner's Notebook has been published continuously since 1944

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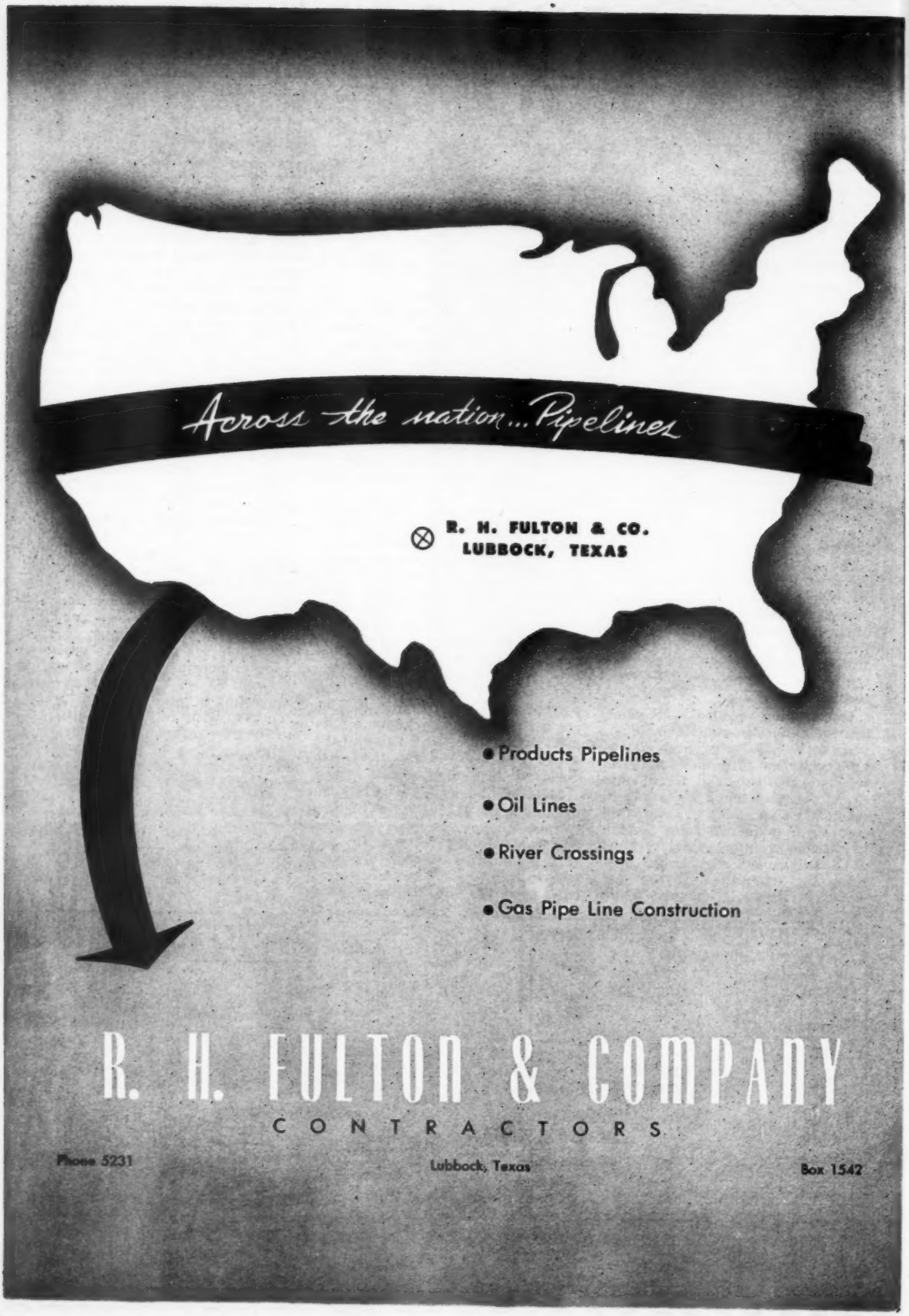
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PIPE LINES

Products Line

Miami Valley Corp. to build 58-mile carrier

CLEVELAND.—Miami Valley Corp., a firm jointly owned by Standard Oil Co. (Ohio) and Pure Oil Co., will construct a 58-mile petroleum-products line between Dayton and Cincinnati which will assure the Dayton area an increased supply of gasoline and other products in event of an emergency.

The 8-in. line will cost approximately $1,400,000. Construction will start in mid-August, and the carrier is expected to be completed by October, S. H. Elliott, vice president of Sohio, in charge of transportation, said.

Increased demands for products of the two firms makes it necessary to expand pipe-line distribution systems in the southwestern part of Ohio, Elliott said. A small pumping station for the new line will be constructed in Dayton, but there will be no station in Cincinnati.

At Dayton, the new Miami Valley line will connect with Sohio's present 6-in. products line from Springfield, which in turn connects to other lines from Toledo, where both Pure and Sohio operate refineries. It will also connect in Dayton with the new Pure terminal to be built there. This terminal will be served from Newark, Ohio, by the new 6-in. line being laid by Pure Transportation Co.

Miami Valley will connect to an existing line in Cincinnati which serves Sohio's present terminal and will connect with Pure's terminal at Sedansville.

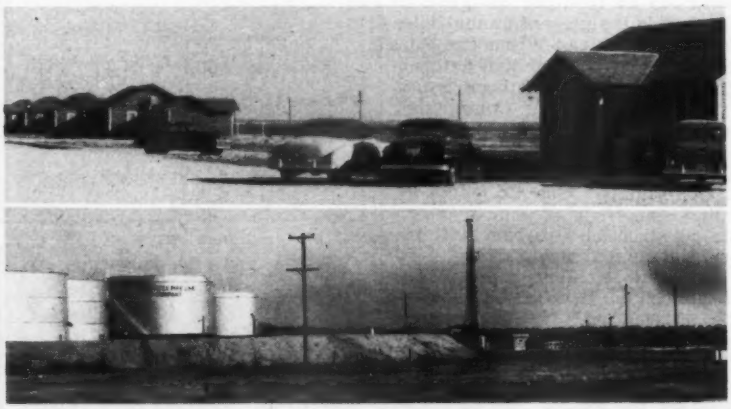
Bechtel Tapline Work

Field reports from the Eastern division of Trans-Arabian Pipe Line Co. indicate that International Bechtel, Inc., working out of Ras el Misha'ab on the Persian Gulf, has completed its portion of the right-of-way for the 1,068-mile, 30-31-in. Tapline which includes 314 miles of Arabian American Oil Co.'s gathering system.

Originally scheduled to build approximately 650 miles of the line, Bechtel has actually cleared 850 miles of right-of-way and is now authorized to lay as much as 845 miles of pipe. Bechtel crews have hauled out and strung 740 miles of pipe, and of that, over 730 miles have been welded.

The forces of the Western Division of Tapline (Williams Brothers Overseas Co.) have so far welded about 100 miles, so this left a gap of only 238 miles in the pipe line between the Persian Gulf and the Mediterranean, as of July 1.

Of the four pump stations being erected by Bechtel for Tapline in Saudi Arabia, one (Qaisumah) has been virtually completed, another (Badanah) is approximately 75 per



SCURRY COUNTY SCENE.—Top photograph shows a row of newly constructed field houses at Lion Oil Co.'s camp in the Diamond "M" field of Scurry County, Texas. Field office is at right. Bottom photograph shows Pasotex Pipe Line Co.'s station in the North Snyder field, now pumping approximately 21,000 bbl. of crude daily through a 6-in. line, which goes 22½ miles southward to the large Basin System pipe line. Plans contemplate an additional 8-in. loop line. The three pumping units are located to the right of drilling rig. There are two temporary 10,000-bbl. storage tanks at extreme left. Two 20,000 bbl. floating-roof tanks are permanent installations, and two 55,000-bbl. tanks are on order.

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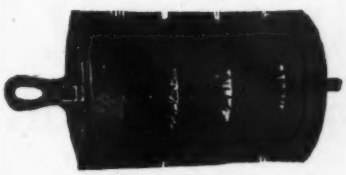

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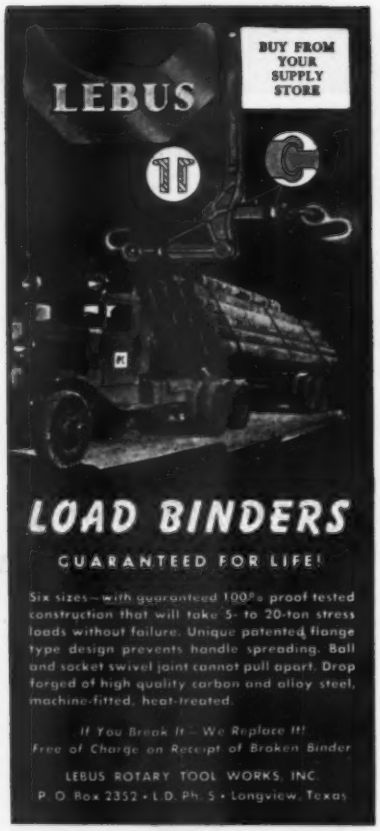

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cent advanced, another (Rafha) is about 60 per cent complete, while the fourth (Nariya) is 55 per cent complete. It is expected that all four of these pump stations, as well as the line itself, will be ready for operation before the end of 1950.

Products Line to Start

PHILADELPHIA.—Construction will begin August 1 on a 125-mile, 8-in. petroleum products line from Sun Oil Co.'s Toledo refinery to Sarnia, Ont., Canada, William C. Kinsolving, president of Susquehanna Pipe Line Co., a Sun affiliate, announced here last week.

Route of the line has been surveyed and construction contract has been let to H. L. Gentry Construction Co., Jackson, Mich. The carrier is scheduled for completion and will be in operation by December 1.

Kinsolving said the new line will be operated as part of the Susquehanna system to deliver gasoline and furnace oils to Sun's River Rouge, Mich., terminal, and carry liquefied gases to a Canadian chemical plant at Sarnia.

The line will run north out of Toledo to Detroit, then northeast from the south of Pontiac, Mich., cross the St. Clair River at Marysville, Mich., and then to Sarnia on the Canadian side.

The Marysville crossing will be from 45 to 50 ft. deep, and the line laid 12 ft. below the stream bed to safeguard against damage.

Michigan-Wisconsin Plan

WASHINGTON.—An opinion and order granting final authorization for construction of facilities designed to nearly double the present annual sales capacity of Michigan-Wisconsin Pipe Line Co.'s Texas-to-Michigan natural-gas pipe-line system has been issued by the Federal Power Commission here.

Authorization involves two companies, Michigan-Wisconsin and Michigan Consolidated Gas Co., both of Detroit.

The construction program will increase the annual sales capacity of the Texas-to-Michigan line from 56,575,000,000 cu. ft. to a new total of 110,595,000,000 cu. ft. Daily sales capacity will be increased from 155,000,000 to 303,000,000 cu. ft.

The expansion program involves installation of 139,200 hp. of additional compressor capacity by Michigan-Wisconsin. The line now has an authorized capacity of 29,600 hp. Estimated cost of Michigan-Wisconsin's project is $22,732,000. Michigan Consolidated will install facilities to provide additional storage capacity required in connection with Michigan-Wisconsin's expansion. Over-all capital cost of these facilities is approximately $15,346,500.

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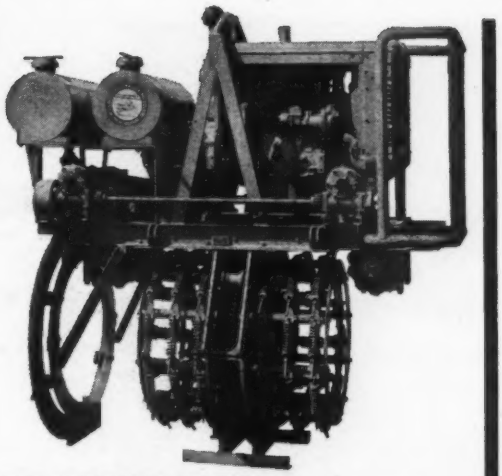
For PIPE CLEANING– CUTTING and BEVELING



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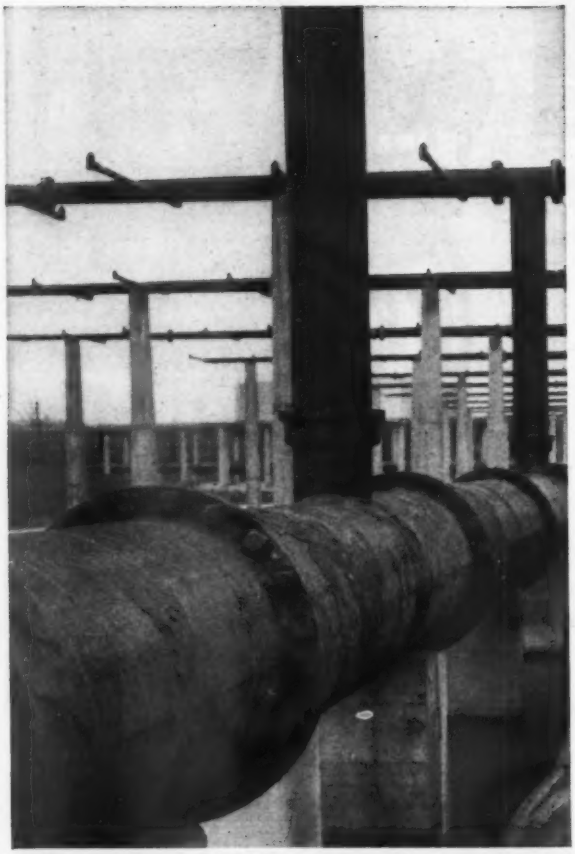

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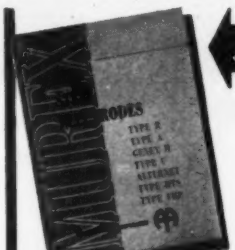

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Pipe-Line Construction

FOLLOWING is a tabulation of domestic pipe-line projects which are planned or under construction. Included are crude-oil, products, and natural-gas lines. The list was compiled from surveys made by The Oil and Gas Journal.

Crude-Oil Pipe Lines

Humble Pipe Line Co.—371 miles, 18-in., under way, West Texas-Satsuma Station to Baytown, Tex.; 178-mile western section contracted to Morrison Construction Co.

30 miles, 8-in., Runnels and Coke counties, Texas, planned.

Lakehead Pipe Line Co.—320 miles, 18-in., Neche, N. D., to Superior, Wis.; Anderson Brothers Corp., contractor. K. B. Killingsworth, Pembina, N. D., Earl Saulsman, Clearbrook, Minn., and J. D. Jackquemine, Bemidji, Minn., spreadmen. Under construction.

Magnolia Petroleum Co.—60 miles 4-24-in. gathering system in La Ward and Lolita fields, Texas; Henry L. Lemons & Co., contractor; W. A. Remington in charge.

Mid-Valley Pipe Line Co. (Sun and Sohio)—1,000 miles, 20-22-in., under way, Longview, Tex., to Mayersville, Miss.-Covington, Ky., to Lima, Ohio. Contracts let for 857 miles as follows: Section 2, Haynesville, La., to Mayersville, Miss., completed. Section 3-A Mayersville to Oakland, Miss., Associated Pipe Line Contractors, Inc.; J. A. Williams and L. H. Gray, spreadmen; field office, Charleston, Miss.; Section 3-B 4-A, Oakland, Miss., to Henderson, Tenn., Houston Contracting Co., E. C. Norris, superintendent; field office, Batesville, Miss.; Section 4-B, 5-A, Henderson to Clarksville, Tenn., Eastern Construction Co.; work started April 1; to be completed by September 1, 1950. Louie Stewart and Cliff Simmons, spreadmen; field offices, Clarksville and Lexington, Tenn. Section 5-B, 6-A, Clarksville, Tenn., to Elizabethtown, Ky., field office, Clarksville, Fred L. Byers, superintendent; Britton Construction Co.; Section 6-B, 111 miles of 22-in., Elizabethtown to Hebron, Ky., H. L. Gentry Construction Co., Frank Morris and Jim Mitchell, spreadmen; field office, Warsaw, Ky., Section 7 South, Hebron, Ky., to Eaton, Ohio, Britton Construction Co., field office, Hamilton, Ohio; spreadman, Fred Peters; Section 7 North, Eaton to Lima, Ohio; Section 8, Magnolia, Ark., to Haynesville, La. Longview, Tex.-Haynesville, La., section, 110 miles 20-in., contracted to O. R. Burden Construction Co.; G. A. Lewis, spreadman; office, Marshall, Tex.

Cumberland and Tennessee rivers, Eastern Construction Co.; field office, Clarksville, Tenn., Fred L. Byers, spreadman.

41 miles, 20-in., Haynesville, La., to Red River near Benton La.; Latex Construction Co., contractor; H. L. Leake, superintendent; headquarters, Cotton Valley, La. W. A. Briley, assistant superintendent; Sam B. Harrison, office manager.

Naph-Sol Refining Co.—25 miles 6-in., under construction, Kimball Lake oil field, Newaygo County, Michigan, to refinery at Muskegon; Young Construction Co., Olney, Ill., contractor.

Pan American Pipe Line Co.—80 miles, 10-in., southern part of Scurry County, Texas, to connect with Humble Pipe Line Co.'s system near San Angelo, Tex. Brown & Root, contractor.

Pelican Oil Co.—60 miles, 6-in., Lake Charles, La., area; Anderson Brothers Corp., contractor; field office, De Quincy, La.; R. W. Jernigan, spreadman. Under construction.

Phillips Petroleum Co.—45 miles 2-24-in., gathering system near Andrews, Tex.; Vaughn & Taylor Construction Co., contractor; Jess Moore in charge.

281 miles 10-in., planned, Borger, Tex., to Yale, Okla.

Pasotex Pipe Line Co.—32 miles 4-8-in., authorized, North Snyder, Tex., lines for gathering, delivery to Basin System.

Portland Pipe Line Co., Montreal Pipe Line Co., Ltd.—236 miles, 18-in., planned, Portland, Me., to Montreal, Que., Canada, contracted as follows: Oklahoma Contracting Co., 85 miles in Section 1 at southern end; Portland, Me., to Gorham, N. H.; H. A. Wylie, superintendent; Lisle W. Chambers, paymaster; office, Barton, Vt.; work starts June 1. Associated Pipeline Contractors, Inc.; L. H. Gray, spreadman. Section 2, 81 miles; and Fred Mannix Co., Ltd., 68 miles, Section 3, in Canada.

Richfield Oil Corp.—40 miles, 10-in., Cuyama Valley-Newhall, Calif., planned. 60 miles, 14-in., applying field joints, Newhall-Wilmington, Calif., under way.

Stanolind Pipe Line Co.—36 miles, in Kent County, Texas, outlet for Scurry County crude.

Texas-Empire Pipe Line Co.—42 miles, 16-in., authorized, Wilmington, Ill., to East Chicago, Ind.; O. E. Burden Construction Co., contractor; O. P. Hines, spreadman; office, Chicago Heights, Ill.

Texas Pipe Line Co.—42 miles 12¾-in., Patoka, Ill., to Clay City, Ill.; L. R. Young Construction Co., contractor; field office, Fiora, Ill.: Whity Ralph, spreadman.

Texas-New Mexico Pipe Line Co.—37 miles, 10-in., proposed, Scurry County, Texas.

Products Pipe Lines

Great Lakes Pipe Line Co.—261 miles, 12-in., under way; contracted as follows: 52 miles, 15-in., Albert Lea to Fairbault, Minn.; under construction; Sheehan Pipe Line Construction Co., contractor; field office, Albert Lea, Minn.; C. W. Henderson, spreadman. 50 miles 12-in., St. Paul to Fairbault, Minn.; J. W. Brown, spreadman; office, Northfield, Minn. 50 miles 12-in., State Line to Fairbault, Minn., C. M. Brown, spreadman; office, Albert Lea, Minn. O. R. Burden Construction Co., 64 miles north from Des Moines; field office, Nevada, Iowa; G. D. Lewis, spreadman; A. C. Holder Construction Co., 72 miles to Iowa-Minnesota state line; Williams Brothers Corp., 20 miles, Mississippi River crossing and line to terminal and station. Kansas and Missouri river crossings, R. H. Fulton & Co.; field office, Kansas City; Ed Veach, spreadman.

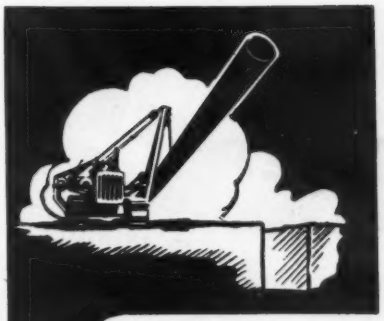
Second 12-in. line to be constructed between Barnsdall, Okla., and Kansas City, Kans., paralleling the 12-in. recently completed, and three existing 8-in. lines. Work to start as soon as pipe is delivered.

47 miles, 12-in., Atchison, Kans.,-Fall City, Neb.; Midwestern Constructors, Inc., contractor; field office, Falls City. This firm has following contracts, also: 47 miles, 12-in., Falls City to Nebraska City; field office, Nebraska City; and 48 miles, 12-in., Nebraska City to Omaha; field office, Plattsmouth, Neb.

290 miles, 12-in., Tulsa to Kansas City, Mo. Contracted as follows: 54 miles, Ponca City to Barnsdall, Okla., O. R. Burden Construction Co.; and 236 miles, Barnsdall, Okla.-Kansas City, Mo., Pacific Pipe Line & Engineers, Ltd. James Howe, superintendent for Pacific Pipe Line portion is headquartered at Chanute, Kans.; spread office at Tulsa with Ham Hamilton general spreadman and river-crossing spreadman; spread office at Dewey, Okla., Loue Robertson, spreadman; and spread office at Paola, Kans., Larry Webb, spreadman.

355 miles, 12-in., authorized, Kansas City through Omaha and Sioux City, Iowa, to Sioux Falls, S. D.

189 miles, 12-in., authorized, Kansas City to Des Moines, contracted as follows: 36 miles 12-in., Kansas City, Mo., northward through Platte, Neb.; Trojan Construction Co., contractor; field office, Parkville, Mo.;



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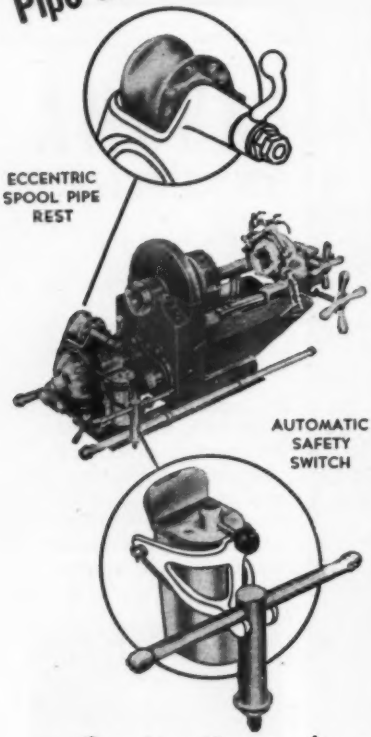

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Swede Tillotson, spreadman; 37½ miles, 12-in. Clay, Clinton, DeKalb, and Daviess counties, Missouri; Trojan Construction Co., contractor; field office, Cameron, Mo.; Felix Johnson, spreadman; Brodie Construction Co., 37-mile middle section; field office, Bethany, Mo.; A. T. Rathjen, spreadman; R. H. Fulton & Co., two 38-mile northern sections, Osceola to Des Moines, Iowa; Jerry Nash, spreadman; office, Osceola.

48 miles, 8-in., authorized, Cushing-Drumright-Tulsa, Okla.; Trojan Construction Co., contractor; field office, Sapulpa, Okla.; Slim Deaver, spreadman.

Phillips Petroleum Co.—155 miles 6-in., extension to present 200-mile line from Phillips, Tex., to LaJunta, Colo., on to Denver.

Plantation Pipe Line Co.—New products line planned paralleling existing 456-mile, 12-in. from Baton Rouge, La., to Bremen, Ga., and 357 miles 10-in., Bremen to Greensboro, N. C. Work to begin January 1, 1951.

Standard Oil Co. (Ohio).—38 miles 8-in., authorized, Toledo to Fostoria, Ohio.

Salt Lake Pipe Line Co.—242 miles, 6-8-in., Boise, Idaho-Pasco, Wash., planned. Contracted as follows: Morrison-Knudson Co., Inc., Macco Corp., and Bechtel Corp., 140-mile section from Boise to Baker, Idaho; Pacific Pipeline & Engineers, Ltd., Baker to Pasco, Wash. Pacific Pipeline & Engineers, Ltd.'s, field office, LaGrande, Ore.; L. E. Robertson, spreadman.

63 miles 8-in., Mountain Home to Boise, Idaho; Oklahoma Contracting Corp., contractor; Aldress Kilgore, supt.; R. F. Mueller, paymaster. Office, Mountain Home. Construction under way.

Tuscarora Oil Co. (Esso).—360 miles, 10-12-in., Linden, N. J., to Pittsburgh; replacement of present line.

Natural-Gas Pipe Lines

Alabama-Tennessee Natural Gas Co.—80 miles 10-in., under way, Selmer, Tenn., to Muscle Shoals, Ala.; 35 miles 8-in., authorized, Muscle Shoals to Decatur, Ala.

Algonquin Gas Transmission Co.—276 miles, Lambertville, N. J., to Boston area, proposed.

492 miles laterals, New England area, proposed.

Arkansas-Louisiana Gas Co.—69 miles, 20-in., Waskom, Tex., to Magnolia, Ark.; under construction; Anderson Brothers Corp., contractor; Ralph Pitts, spreadman; field office, Plain Dealing, La.

Associated Pipe Line Co.—35 miles, 14½, 8⅝-in., in southeastern Missouri, approved.

Atlantic Gulf Gas Co. (United Gas Pipe Line Co.)—1,530 miles, planned, Alabama-Florida-Georgia-South Carolina.

Central Hudson Gas & Electric Corp.—40 miles, authorized, Tuxedo, N. Y., station. Home Gas Co. line now under construction, to Poughkeepsie, N. Y. Britton Construction Co., contractor; field office, Newburgh, N. Y.; spreadman, Curley Hahn; R. L. Carlton, office.

Central Kentucky Natural Gas Co.—41 miles, 20-in., approved, Kentucky loops.

Chicago District Pipe Line Co.—41 miles, 24-in., planned, Joliet, Ill., to Chicago.

City of Indianapolis, Ind., Inc.—55 miles 16-in., proposed, Indianapolis to Texas Eastern Transmission Corp.'s system.

Cities Service Gas Co.—47 miles, 3-4-16-in. planned, in Kansas.

Coastal Pipe Line Co.—1,000 miles, planned, Texas to Norfolk, Va.

Colorado-Wyoming Gas Co.—41 miles, planned, Greeley, LaSalle, and Windsor, Colo., areas. Vaughn & Taylor Construction Co., has contract for 30 miles, 10-in., Mesa to Boulder Junction, Colo.; field office, Derby, Colo.; Don Smith, spreadman.

Commonwealth Natural Gas Corp.—537 miles, 20-in., planned, West Bend, Ky., to Norfolk, Va.

200 miles, authorized, Green County, Virginia, to Norfolk; 104 miles 18-in. contracted to Ray L. Smith & Son, Inc., from Standardsville to Richmond, Va. Don C. Smith, spreadman; field office, Orange, Va.; William G. Frost, spreadman; field office, Richmond. Also 84 miles 12-in., 20 miles 8-in. and laterals contracted to this company.

East Tennessee Natural Gas Co.—185 miles, 16-in., Lobelville-Chattanooga, Tenn.

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contracted by Walters & Saigh Construction Co., for construction in 1950; 120 miles, 12-in., Chatanooga-Knoxville, Tenn.; contracted by Walter and Saigh Construction Co., for construction in 1950; Robert E. Floyd, spreadman; field offices, Athens and Cleveland, Tenn.; Carl Doyle, general superintendent; James E. Gray, office manager; 100 miles of laterals to be laid in 1950. Construction 150 miles, 16-in., Knoxville-Bristol, Tenn., under consideration.

El Paso Natural Gas Co.—All work done by company crews.

Looping of 26-in., New Mexico-California line and connection with Pacific Gas & Electric Co. at Needles, Calif. 352 miles, 30-in., completion November 1950; spreads as follows: 119 miles 30-in., Wenden to Topock, Ariz., Ed Alsup, spreadman; office, Salome, Ariz.; (Spread No. 2 is shut down due to lack of pipe; office, Jal, N. M., Jack Smith, spreadman); 15 miles 2-in., Bowie, Ariz.; G. George, spreadman.

450 miles, 30-in., under construction, Eunice, N. M.-Blythe, Calif., looping; completion March 1950.

450 miles, 24-in., approved, San Juan basin, New Mexico to Franconia, Ariz.

Home Gas Co.—70 miles, planned, Orange, Sullivan-Rockland counties, New York-Cattaraugus County, New York, areas.

Jersey Central Power & Light Co.—39.4 miles, 10-in., planned, New Jersey to Coast system, Texas Eastern Transmission Co.'s Big Inch.

Michigan-Wisconsin Gas Co.—185 miles, 4-14-in. laterals, Milwaukee-Fond du Lac, Sheboygan, and Green Bay, Wis., under construction; C. C. Griffis Construction Co., contractor; Paul Means, superintendent for Lake Del Mort crossing.

Montana-Dakota Utilities Co. and Montana-Wyoming Gas Pipe Line Co.—340 miles, 12¾-in. under way, Worland, Wyo., to Cabin Creek, Mont.; R. A. Conyes Construction Corp., contractor; Al Poggi, general superintendent; Chester Kincaid and Jimmy Alman, spreadmen; field office, Hardin, Mont.

Montana Power Co.—83 miles, 12¾-in., planned, Butte to Bozeman, Mont.; field office, Three Forks, Mont.; C. N. Deaton, spreadman.

New York State Natural Gas Corp.—53½ miles 16-in., loops, Pennsylvania.

164 miles, 16-in., Ithaca to Albany, N. Y., planned.

70 miles, 20-in., North Oakford storage pool, Pennsylvania, to Ohio State line.

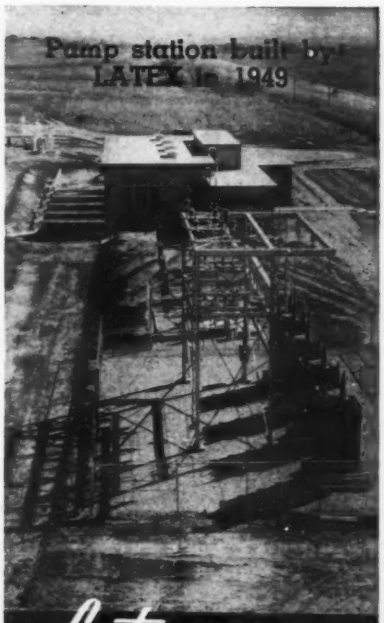
53 miles, 16-in., loops in Pennsylvania, under construction.

56 miles, 20-in., loops in Pennsylvania and New York; under construction.

Northeastern Gas Transmission Co.—511 miles, up to 20-in., planned, in New England area.

Northern Natural Gas Co.—41 miles, 20-in., under construction, Southwest from Garden City, Kans.; R. H. Fulton & Co., contractor.

597 miles of looping in 10 sections, contracted as follows: R. H. Fulton & Co., loops 1 to 5: loop 1, 40.2 miles, 26-in., extending northward from a point 28.7 miles north of Skellytown station in Pampa, Tex., area; loop 2, Beaver, Okla., station, 74.9 miles, 26-in.; loop 3, Mullinville, Kans., station, 33¼ miles, 26-in.; loop 4, Bushton, Kans., station, 72½ miles, 26-in.; loop 5, from a point west fo Garden City, Kans., to Bushton, Kans., station, 155 miles, 20-in. M. L. Boyd, spreadman; office, Perryton, Tex.; and N. A. Veach, spreadman; office, Liberal, Kans. Midwestern Constructors, Inc., loops 6 and 7; loop 6 from a point 29 miles northeast of Palmyra, Nebr., station, 43.4 miles, 26-in., to Oakland, Iowa, station; loop 7, from a point 17.8 miles northeast of Oakland, Iowa, station, 65.9 miles, 26-in; office, Glenwood, Iowa. R. B. Potashnick, loops 8 to 10; loop 8, southwestward from Ventura, Iowa, station, 31.2 miles, 26-in.; loop 9, northward from Ventura station, 41 miles, 26-in.; loop 10, from the north end of a 26-mile gap beyond loop 9, where another loop will be built consisting of 39½ miles, 26-in.; total 111 miles, 24-



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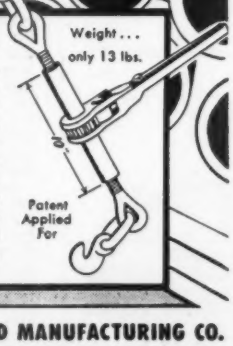

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in.; field office to be located at Ogden, Iowa, June 1; Boyd, spreadman.

Northwest Natural Gas Co.—750 miles, planned; Washington Oregon, and Idaho.

Pacific Gas & Electric Co.—506 miles, 34-in., under construction, Topock, Ariz.-Milpitas, Calif.; Bechtel-Price-Conyes, contractor; main-line office, Barstow, Calif.; R. L. Bowman, general superintendent.

Panhandle Eastern Pipe Line Co.—160 miles, additions to present system; approved. Also, 188 miles to be built in conjunction with the 160-mile project, along entire system. (Previously approved by FPC.)

69 miles 26-in. loops, Olpe to Hugoton, Kans.; Midwestern Constructors, Inc., contractor; office, Ottawa, Kans.; M. L. Wilhite, superintendent.

Panhandle Eastern Pipe Line Co.—358 miles, 26-in., authorized, looping in Texas, Oklahoma, Kansas, Missouri, Illinois, Indiana, Ohio, and Michigan.

75 miles, 26-30-in., loops in Illinois, Indiana, Missouri; Anderson Brothers Corp., contractor; field office, Rockville, Ill.; J. A. Brown, spreadman; office at Winchester, Mo.; Dewey Whitworth, spreadman. Under construction.

Peoples Gas Light & Coke Co.—Planned 42 miles, 24-in., Joliet-Chicago, Ill.

Phillips Petroleum Co.—25 miles gathering system in West Edmond, Okla., field; under construction; Vaughn & Taylor Construction Co., Inc., contractor; spread office Edmond, Okla.

118 miles, 3-to-20-in., gas-gathering system in Sherman and Hansford counties, Texas; Vaughn & Taylor Construction Co., Inc., contractor; D. D. Vaughn, spreadman; field office, Texhoma, Okla.

Phillips Petroleum Co.—118 miles 3-26-in., gas-gathering system, Sherman and Hansford counties, Texas; Vaughan & Taylor Construction Co., Inc., contractor; field office, Texhoma, Okla.; D. D. Vaughn and Jess Moore, spreadmen. Work 60 per cent complete.

Piedmont Natural Gas Corp.—1,350 miles, 20-in., planned, Greenville, Miss., to Norfolk, Va.

Plains Natural Gas Co.—78 miles, gathering system, Oklahoma-Kansas area, Hugoton field. Contracted by: Arey-Phillips Construction Co., Amarillo, Tex.; Tulsa Pipe Coating Co., Mid-Western Constructors, Inc., Engineering and supervision. Latter firm represented by Lyle DeWitt; field office, Liberal, Kans.

Roanoke Pipe Line Co.—30 miles 8-in., Gala, Va., to Roanoke, authorized.

South Jersey Gas Co.—77 miles, planned, Camden to Atlantic City.

Southern California Gas Co.—80 miles 30-in., Whitewater to Puente, Calif., under way; field office, Bonning, Calif.

Southern Natural Gas Co.—Following program approved by FPC (Docket G-1308): scheduled for 1950.—180 miles, 18-in., Gwinville, Miss., to Selma, Ala.; Sheehan Pipe Line Construction Co., contractor; 26 miles, 16-in., Selma to Marvin Gate, Ala.; 29 miles of 12-in., Carthage, Tex., to Logansport, La.; 14 miles, 14-in., Logansport to Perryville, La.; 5.8 miles of 8-in., Carthage field, Texas; 13.2 miles, 24-in., Benton-Pickens loop in Mississippi; 4 miles, 24-in., Coosa-Talladega loop, in Alabama; 4 miles, 24-in., Tallapoosa-Bowden loop in Alabama; 11 miles of 6-in., Vicksburg loop in Mississippi; 6.2 miles, 12-in., Macon line loop, in Georgia; and the following connecting lines: 5 miles, 8-in., Meridian, Miss.; 1 mile, 8-in., Demopolis, Ala.; 35 miles, 8-in., La Grange, Ga.; 6.3 miles, 6-in., Lanett, Ala.; 6.2 miles, 8-in., Mississippi Chemicals Co. plant; 22 miles, 8-in., Childersburg, Ala.; 2 miles, 6-in., Beaunit Mills; and 12.6 miles, 12-in., Yates plant.

Scheduled for 1951.—45.6 miles, 18-in., and 22.9 miles, 16in., Selma to Marvin Gate, Ala.; 98.1 miles, 16-in., Marvin Gate to Bolingbroke, Ala.; 105 miles, 10-in., Bolingbroke Gate to Augusta, Ga.; 19 miles, 8-in., Augusta to Aiken, S. C.; 27.2 miles, 14-in., and 36.9 miles, 14-in., Logansport to Perryville, La.; 21.4 miles, 24-in., Perryville-Pioneer loop in Louisiana; 14.4 miles, 24-in., Onward Big Sunflower loop, in Louisiana; and the following connecting lines: 16.8

miles. 6-in., Grantville, Ga.; and 15.5 miles, 4-in., Sandersville, Ga.

Southern Union Gas Co.—78 miles, 8-10-14-in., planned, New Mexico loops and laterals.

Tennessee Gas Transmission Co.—65 miles, 16-in., planned, Ohio-Pittsburgh spur.

40 miles, 16-in., Beaver Falls-Pittsburgh, Pa., Britton Construction Co., contractor; office, Beaver Falls; Fred McKenzie, superintendent.

750 miles, 20-26-in., planned, Burnaugh, Ky., to Boston, including 400-mile line to Buffalo.

992 miles, 30-in., planned, first 150 miles of loops to be laid at Monroe, La., Greenville, Miss., Midland and Portland, Tenn.

385 miles 26-in., Greenup County, Kentucky, to New York; contracted to H. C. Price Co., Bartlesville, Okla.

Latex Construction Co. has following contracts: 123 miles, 30-in., West Monroe to Many, La., W. H. Hayes, superintendent, field office, Jonesboro, La.; 95 miles, 30-in., Natchitoches to Kinder, La.; F. A. Silar, superintendent, W. A. Briley, assistant; field office, Kinder, La. 75 miles, 16-in., Kinder to Bayou Sale, La., F. A. Silar, superintendent.

54.2 miles, 30-in., under construction White Bluff area to Joelton, Tenn., area contracted to Morrison Construction Co.

38.1 miles, 30-in., under construction Glasgow, Ky., area to Joelton area, contracted to Morrison Construction Co.

18.1 miles, 30-in., under construction Union City to Buckeye, Ky., Anderson Brothers Corp., contractors.

47 miles 30-in., Glasgow to Lebanon, Ky.; H. C. Price Co., contractor; field office, Scottsville, Ky.; R. L. McMillon, spreadman.

99 miles 30-in., under way, Dickson to Selmer, Tenn.; field office, Dickson, Tenn.; Jack Hodges, spreadman.

63 miles 26-in., Mahoning River near Youngstown, Ohio, southward; H. C. Price Co., contractor; G. A. Reutzel, supt.; field office, Columbiana, Ohio. 63 miles 26-in., Muskingum River northeastward; R. K. Shivel, supt.; office, Zanesville, Ohio; 47 miles 26-in., Muskingum River southwestward; W. B. Williams, supt.; office, McConnelsville, Ohio; 47 miles 26-in., Ohio River northeastward; C. R. Ice, supt.; office, Portsmouth, Ohio. (Balance of 373-mile Ohio River-Buffalo project to be started in August 1950.)

27.7 miles, 12-in., under construction, El Campo, Tex., to near Traitor, Tex.; Massey Construction Co., contractor.

25 miles. 30-in., Hardeman and McNairy counties, Tennessee; H. C. Price Co.; field office, Selmer, Tenn.; J. A. Reutzel, spreadman.

174 miles, 30-in. loops in western Tennessee and Kentucky; Price-Morrison, contractor; R. L. McMillon, spreadman; office, Scottsville, Ky.; Jack Hodges, spreadman; office, Dickson, Tenn.

103 miles 30 and 26-in. loops, Premont to El Campo, Tex.; Oklahoma Contracting Corp., contractor; M. E. Shiflett, supt.; Joe Freeman, paymaster. Work under way.

60 miles, 30-in., between stations 104 and 99; Anderson Brothers Corp.; field office, Richmond, Ky.; A. G. Hobson, spreadman. 65 miles, 26-in., Station 110 to Ohio River; field office, Moorehead, Ky.; E. C. McCoy, spreadman.

170 miles of 26 and 30-in., contracted by Anderson Brothers Corp., in Kentucky

91 miles 30-in., Holly Springs, Miss., south; contracted to Oklahoma Contracting Corp.; Raymond Law, supt.; Gene Gohring, paymaster; office, Holly Springs; work to begin June 1.

Texas-Eastern Transmission Corp.—1,400 miles planned, Texas to Pittsburgh loops.

108 miles 16-in., authorized, Provident City to Baytown, Tex.

Texas Gas Transmission Corp.—103 miles, 20-in., Carthage, Tex., to near Lisbon, La., (Sharon); under construction; N. A. Saigh Co., Inc., contractor; Carthage, Tex.; Bob Floyd, representative. Construction subcontracted: (1) Fowler Brothers, 43 miles from Carthage to Red River, field office at Carthage; M. C. Johnson, spreadman; (2) 63 miles to Sharon station, Oklahoma Contracting Co. (J. R. Horrigan) field office at Minden, La.; Ed Flanagan, spreadman.

32 miles, planned, Slaughters, Ky., to Evansville, Ind.

Texas Illinois Natural Gas Pipeline Co.—1,400 miles, 30-in., approved, La Gloria field, Texas, to Joliet, Ill.

58-mile, 20-in. lateral, Joliet terminal to connection with Natural Gas Pipeline Co. of America near Volo, Ill.

Transcontinental Gas Pipe Line Co.—Texas-New York 1,840 miles, 30-in., main line and 500 miles, 4 to 22-in., gathering line. Section of 605 miles of 30-in. nearing completion.

Section 6, Newman, Ga., to Danielsville, Ga., 108 miles; Williams Brothers Co.; field office, Monroe, Ga.; Thelmer Davis, spreadman. Section 7, Danielsville, Ga., to Saluda River, South Carolina; 86 miles; Williams Brothers Co. Section 8, Saluda River, South Carolina, to Catawba River, North Carolina, 102 miles; R. H. Fulton & Co. Section 9, Catawba River, North Carolina, to North Carolina-Virginia boundary, 100 miles; Clark Williams, spreadman; field office, Spartanburg, S. C. R. H. Fulton & Co.; A. A. Corrigan, supt.; Clark Williams, general supt. Section 10, North Carolina-Virginia boundary to James River, Virginia, 86 miles; O. R. Smith Contracting Corp. Section 11, James River, Virginia, to Potomac River, Virginia; 110 miles; O. R. Smith Contracting Corp. Section 12, Potomac River, Virginia, to Susquehanna River, Pennsylvania, 76 miles; Associated Engineers & Contractors, Inc., spreadman, Cecil Rogers; field office, Towson, Md.; Section 13, Susquehanna, Pennsylvania, to Delaware River, 90 miles; Wunderlich & Griffis Construction Co. Section 14, Delaware River to Hackensack River, New Jersey, 61 miles; Wunderlich & Griffis Construction Co. Section (unnumbered), Hackensack River, New Jersey, to Hudson River, New York, 23 miles; Oklahoma Contracting Co.; field office, Edgewater, N. J.; M. E. Shiflett, spreadman.

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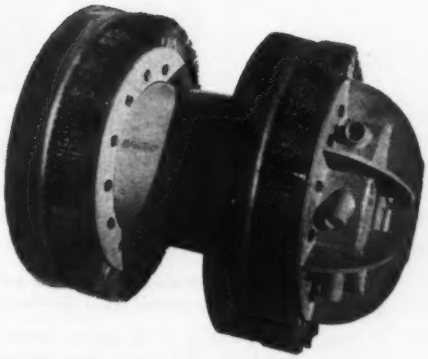

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XUM

NATURAL GAS

Plan Draws Opposition

WASHINGTON. — Texas Eastern Transmission Corp.'s joint proposal with New York State Natural Gas Corp. to develop a $37,750,000 underground-storage project in Pennsylvania, has met opposition from Tennessee Gas Transmission Co.

Hearings are now under way here before the Federal Power Commission on the two former firms' application, which includes proposal to construct two connecting pipe lines totaling 105 miles.

Henry T. Holland, T.G.T. counsel, said the storage project "could be a good thing" for Texas Eastern if it were to be used only in supplying its present customers, but added that it is Texas Eastern's intention to use the storage to serve future needs of Algonquin Gas Transmission Co., which wants to pipe natural gas into the New England area.

T.G.T., on the other hand, has proposed that it supply the New England market through the North Eastern Gas Transmission Co. Holland argued that for Texas Eastern to use the storage facilities in connection with New England at this time would not only be "unfeasible" but also "rash and foolhardy."

He said New England could not possibly derive any immediate benefits from the project. Transcontinetal Gas Pipe Line Corp., a supplier of T.G.T., supports Tennessee's position.

William Cooper, New York State Natural's counsel, said gas stored in the Oakford area of Westmoreland County, Pennsylvania, would be sold to Peoples Natural Gas Co., Pittsburgh, an affiliate, and East Ohio Gas Co.

New York State Natural would construct a 70-mile, 20-in. line from the storage area to a connection with East Ohio's system, and Texas Eastern would build a 35-mile, 30-in. line from near Connellsville, Pa., to Oakford.

P.C.G.A. Program Announced

SEATTLE.—Complete program arrangements have been announced by the Pacific Coast Gas Association in connection with its fifty-seventh annual meeting, which will be held here July 31-August 3.

The convention will be held at the Olympic Hotel on July 31, with H. Henry Gellert, president of the association, serving as chairman. On August 1, Gellert, who is president of Seattle Gas Co., will deliver the initial convention address. The remainder of that day will be devoted to various committee reports. Among papers to be presented on August 1 to 3, are: "The Role of Regulation," by Owen Clarke, chairman, Washington Public Service Commission, Olympia; "Financing Utility Expansions in the Northwest," by Joseph Muckley, vice president, Seattle-First National Bank; and "High B.T.U. Oil Gas for Interim Use and Natural Gas Standby," by K. W. Stookey, president, Gas Machinery Co., Cleveland.

Atlantic Gulf Case Reopened

WASHINGTON. — The proceeding involving proposals to build natural-gas pipe-line facilities in the South has been reopened by the Federal Power Commission, and hearings have been set to begin here September 25. Involved are applications of Atlantic Gulf Gas Co., Southern Natural Gas Co., and United Gas Pipe Line Co.

Atlantic and Southern Natural both are proposing to serve substantially the same areas of Georgia, Florida, South Carolina, and Alabama. United would supply gas to Atlantic.

Compressor Station O.K.'d

WASHINGTON.—Approval has been given by the Federal Power Commission to Arkansas Louisiana Gas Co., Shreveport, to install a new 7,000-hp. compressor station on its natural-gas pipe-line system near Blanchard, La.

The station, estimated to cost $1,507,000, will enable the company to transport gas produced in Louisiana and Texas fields to additional retail customers in Central Arkansas and to make additional volumes of gas available to presently connected customers in Arkansas at required pressures.

Initial installation of three 1,400-hp. units, for a total of 4,200 hp., will give the station a capacity to compress 65,400,000 cu. ft. daily. The remaining two units are expected to be installed before the 1951-52 heating season, bringing the capacity of the station up to 109,000,000 cu. ft. daily.

Facilities Approved

WASHINGTON.—The Federal Power Commission has granted temporary authorization to Cities Service Gas Co., Oklahoma City, to install 3,000 hp. in additional compressor capacity at an existing station and to construct a new 690-hp. station in order to increase the amount of natural gas which may be withdrawn from storage fields in Kansas.

The company will add three 1,000 hp. gas-engine-driven compressor units and appurtenant facilities at its existing North Welda station, in Anderson County, Kansas, to inject and withdraw gas from the North and South Welda storage fields. Cities Service said that installation of these facilities will increase the amount of gas which may be withdrawn from these storage fields by 35,000,000 cu. ft. daily.

The new compressor station, to be located in Johnson County, Kansas, will consist of three 230 hp. gas-engine-driven compressor units and appurtenant facilities. The station will be utilized to withdraw gas from the company's Craig Storage field for delivery into the main line against the high pressure presently carried in order to meet peak-day requirements.

Cities Service plans to abandon its South Welda station in Anderson County, using compressor units reclaimed from this station for installation in the new Johnson County station. The total estimated cost of the project is $885,000.

Natural Gasoline

Sinclair Completes Unit

MARCUS HOOK, Pa.—Sinclair Refining Co. has completed a new unit for production of liquefied propane gas and the installation is now on stream.

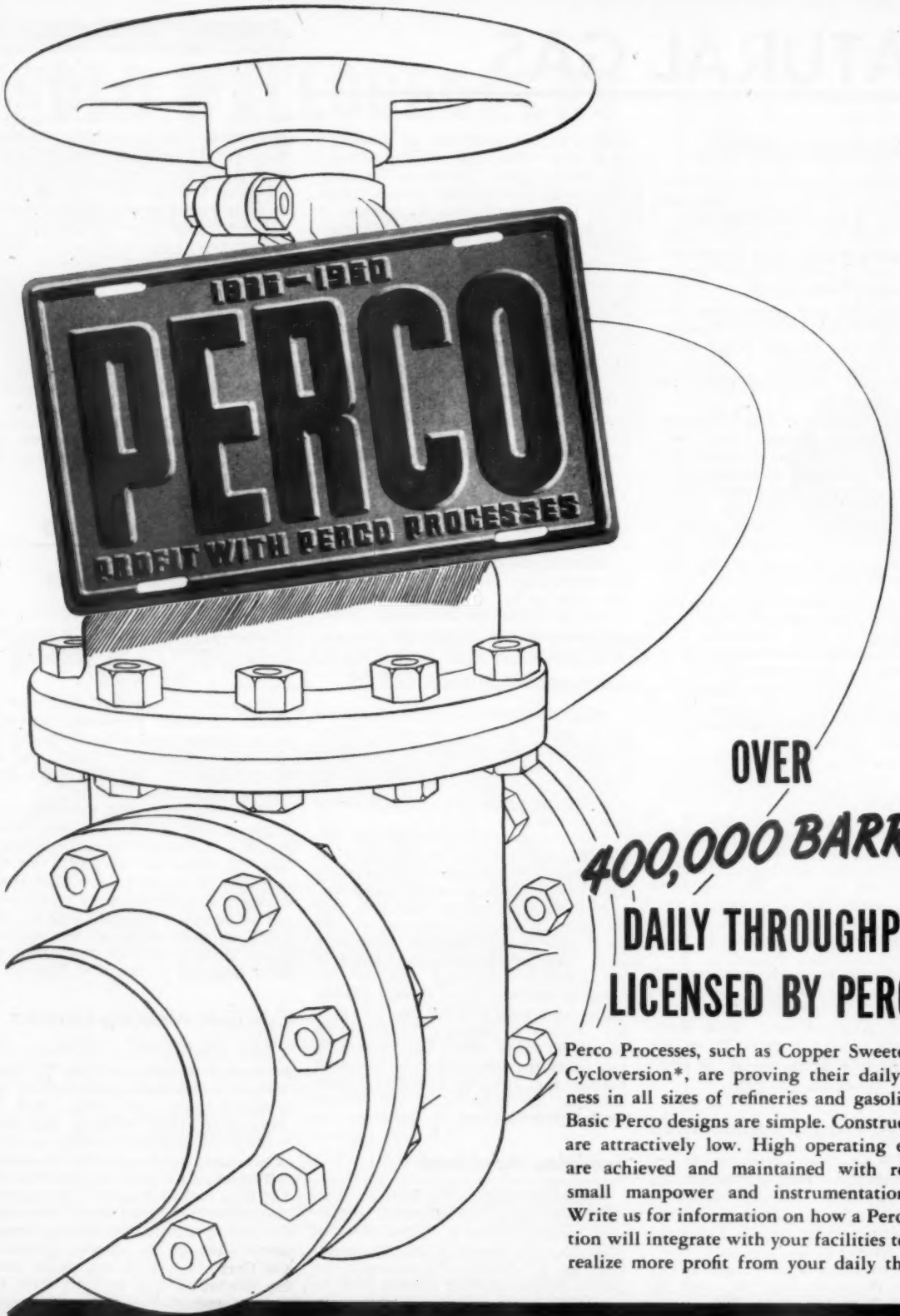
The unit was designed and built by Sinclair refinery personnel, and construction was necessitated by the increased demand for L.P.G. in the North Atlantic and Seaboard area, the company said.

Currently producing a dry, low olefinic-content L.P.G. product which meets all Natural Gasoline Association of America specifications for commercial propane, the unit has a capacity of 1,100 bbl. daily. Shipments are being made daily by tank car and truck to consuming centers in New York, New Jersey, Pennsylvania, the New England states, and Canada.

C.N.G.A. Meeting Planned

LOS ANGELES.—R. S. Tulin, newly elected president of the California Natural Gasoline Association, announced here last week that the association's fall meeting will be a 2-day affair commemorating the silver anniversary of the group's founding.

The meeting will be held November 9-10 in Los Angeles, immediately preceding the American Petroleum Institute's annual convention November 13-16. M. L. Arnold, Richfield Oil Corp., has been appointed meeting chairman, and working with him on the special C.N.G.A. anniversary advisory committee will be Tulin, who is with Shell Oil Co.; H. R. Linhoff, Richfield Oil; William Moeller, Jr., Southern California Gas Co.; and H. L. Eggleston, formerly of General Petroleum Corp.



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REFINING

On Stream

Deep Rock's catalytic cracker now in operation

CUSHING, Okla.—The new catalytic cracking unit at Deep Rock Oil Corp.'s refinery here is now on full stream, W. J. Carthaus, vice president of manufacturing and research, announced last week.

All major units of the company's multimillion-dollar modernization program are virtually completed. The new plants and equipment, started in 1949, are expected to be in full operation by fall and will increase the refinery's daily crude capacity from 12,000 to 18,000 bbl., and bring gasoline-manufacturing facilities up to highest standards, Carthaus said.

Included in the modernization program in addition to the catalytic cracking plant are a new crude-oil topping unit, research and development laboratories, office-building additions, and refinery auxiliary units.

The catalytic cracker, designed by Universal Oil Products Co. and erected by Jones & Laughlin Supply Corp., includes a feed-preparation unit, cracking reactor - regenerator, fractionating section, and gas-concentration unit. It will be able to process more than 5,000 bbl. of crude-cracking stock daily. The modern control unit was engineered by Deep Rock and U.O.P.

The topping unit, in addition to providing charge for the vis-breaker, was designed for the fractionating of naphthas, distillate fuels, and other straightrun products. Included in this unit is new Petreco electric desalting equipment.

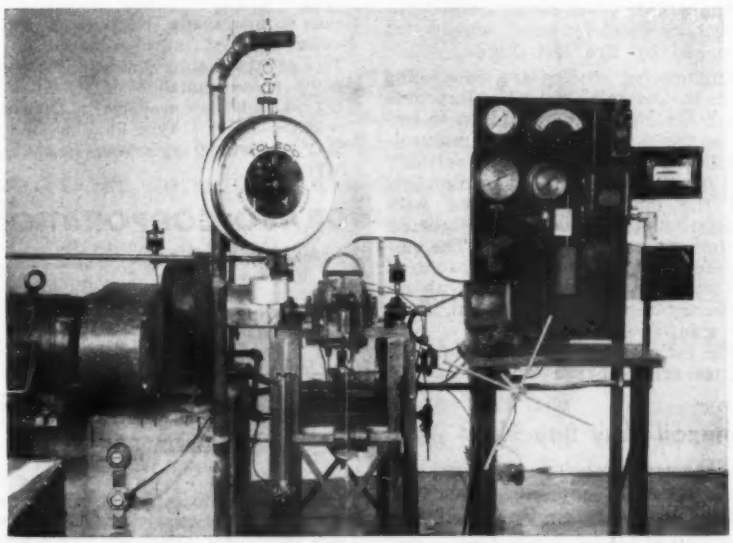
Auxiliary units include a new Ethyl-gasoline-blending plant, 200,000 bbl. additional storage tankage, new loading racks, expanded boiler plant, new cooling towers, and new water lines.

Lube Output Up in May

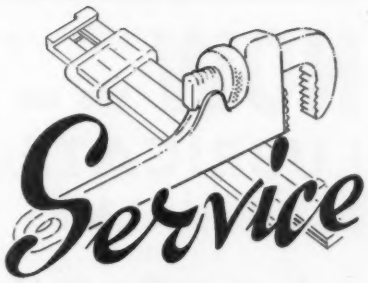
TULSA.—Production of lubricating oils in the Mid-Continent area rose sharply in May this year compared with the same month a year ago, Western Petroleum Refiners Association reported recently.

Summarizing operations of 14 reporting companies, the report for May this year is compared with statistics for May 1949, which were based on reports of 13 companies.

Production totaled 1,524,514 bbl., an



BEARING TESTER.—This device is used by the National Bureau of Standards to test lubrication of plain-journal bearings with various oil-hole patterns and feed systems. It consists essentially of four similar test bearings enclosed in a housing and mounted on a common shaft. The complete unit of bearings and housing acts as a cradle dynamometer. Loads are applied by hydraulic jacks which form the base of the housing. The frictional torque is measured by a dynamometer scale acting through a torque arm fitted to the housing while an automatic device, provided in the hydraulic system, releases the load under high-torque conditions that occur near bearing seizure.



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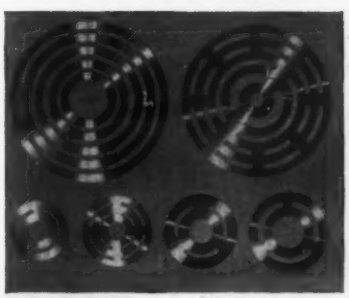

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increase of 470,167 bbl., or 44.6 per cent over May 1949, W.P.R.A. said.

Shipments totaled 1,636,470 bbl., up 500,694 bbl., or 44.1 per cent from the same month a year ago.

Domestic shipments amounted to 1,562,204 bbl., an increase of 461,399 bbl., or 41.9 per cent. Export shipments totaled 74,266 bbl., up 39,275 bbl., or 112.2 per cent over May last year.

Stocks on hand at the end of May dropped 107,970 bbl., or 6.5 per cent, to 1,551,998 bbl. Days' supply on hand was 78 on May 31 this year compared with 115 a year ago, the figures showed.

2,000-Bbl. Refinery Planned

GRAND FORKS, N. D.—Plans are being discussed by Standard Oil Co. of North Dakota and independent oil operators and producers of San Francisco, Los Angeles, and Long Beach, Calif., for building a 2,000-bbl. refinery near here, Harry G. Letts, public-relations man and land man for the oil company, announced last week.

Majority of stockholders of Standard of North Dakota, an independent company, are farmers and business men of the state who are large users of gasoline and other products, Letts said.

Sunray to Rebuild Plant

SANTA MARIA, Calif.—Sunray Oil Corp. of Tulsa, will rebuild and modernize its refinery here, which was damaged by fire last June.

Engineering studies are now being made to determine extent of improvements which will be required to improve the asphalt plant. The natural-gasoline-plant section of the refinery was not greatly damaged by the fire, but the topping plant, along with pumps, tanks, and miscellaneous equipment, are to be rebuilt. The visbreaker was practically destroyed and will be replaced, along with all necessary auxiliary equipment, Sunray said.

The refinery has a capacity of 7,500 bbl. of crude-charge daily.

Pennzoil May Buy Plant

OIL CITY, Pa. — Negotiations are under way for purchase of Waverly Oil Works Co.'s refinery at Pittsburgh by Pennzoil Co. here, and final transactions are expected to be completed and the transfer made around November 1.

It is understood that Pennzoil will take possession of the property and use it for a bulk plant at that time. Stockholders of Waverly earlier had approved a motion to sell the firm's refinery and the Allegheny Railroad to Pennzoil, for $425,000.

It was not stated whether Pennzoil would operate the plant, which has a daily capacity of 2,500 bbl.

McMurrey to Expand

TYLER, Tex.—McMurrey Refining Co. has let contract to Refinery Engineering Co., Tulsa, for materials which will be used to modernize and expand McMurrey's refinery here. Contract calls for $345,000 in equipment.

H. M. McMurrey purchased the property in 1934, and the plant was completely rebuilt and expanded in 1938. Present capacity is rated at 9,000 bbl. of crude charge daily, incuding 4,500 bbl. thermal cracking.

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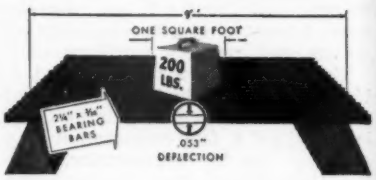

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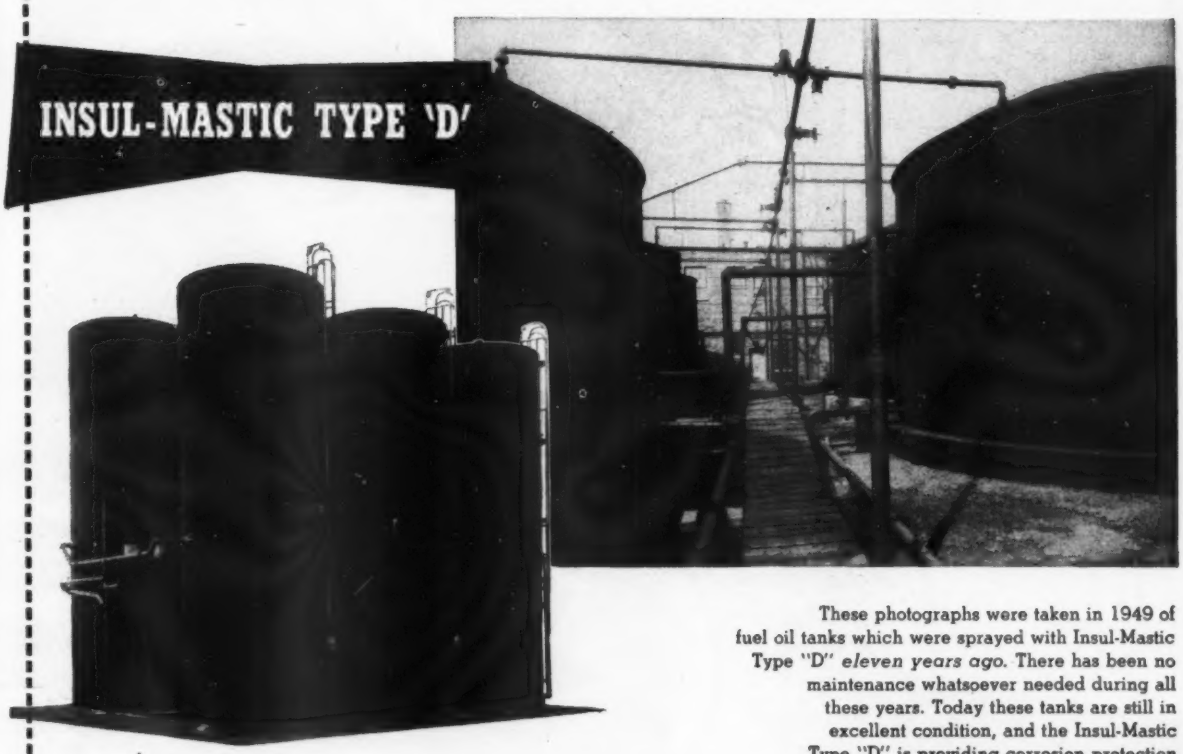

These photographs were taken in 1949 of fuel oil tanks which were sprayed with Insul-Mastic Type "D" *eleven years ago*. There has been no maintenance whatsoever needed during all these years. Today these tanks are still in excellent condition, and the Insul-Mastic Type "D" is providing corrosion protection and unimpaired insulating value.

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Among the Drilling Contractors

Stella Discovery Well Drilled by Wolfe Tools

Wolfe Drilling Co., Tulsa, has another oil discovery for its drilling record. It was the contractor on Gulf Oil Corp. and Faultline Oil Co. 1 Wilson Estate, NE NW NE 27-10n-1e, completed the past week as the initial well for the Southeast Stella pool, northeastern Cleveland County, Oklahoma. The new well, located 6 miles from nearest production, flowed at the rate of 988 bbl. of oil per day from the Trenton-Dolomite at 6,069-6,016 ft. Hole was drilled to a total depth of 6,236 ft. and then plugged back to 6,139 ft.

Sawyer at Midland

Sawyer Drilling Co., Tulsa, has established a district office in Midland, Tex., to handle its operations in the Permian Basin region of West Texas and New Mexico. District superintendent at Midland is W. O. Loftis, who formerly headquartered at Odessa. J. J. Conry is district engineer, and Don Cottier, office manager.

ROTARY RIGS IN OPERATION*
(United States and Western Canada)

Area—	Week ended 7-17-50	Change week ended 7-10-50	Change week ended 7-18-49
Gulf Coast	504	—17	— 19
W. Tex.-N.M.	733	—10	+222
Ark.-N. La.-E. Tex.	153	+ 9	— 6
Oklahoma	281	— 8	+ 59
Kansas	130	0	+ 8
Illinois-Eastern	130	—10	+ 2
Rocky Mountains	96	— 7	— 16
Pacific Coast	140	+ 7	— 38
Total U. S.	2,167	—36	+212
Western Canada	89	— 5	+ 20
Total	2,256	—41	+232

*Courtesy Hughes Tool Co. Trends in drilling activity for the United States and the Arkansas-North Louisiana-East Texas and the Gulf Coast areas are shown by graphs on pages 378 and 379.

New Contracting Firm

Edwin Eckhart, Ealter Ehlo and Ward Kelley have organized Precision Prospecting, Inc., with headquarters at San Antonio, to engage in contract drilling of core holes, stratigraphic tests and other wells not to exceed a depth of 2,600 ft. The new company has two light rigs, each

On Carl Perry's rig, drilling for Freeport Sulphur Co. on the Batson Dome, Hardin County, Texas Gulf Coast. Back row, left to right: H. J. Smith, member of drilling crew; Jack Gaffron, engineer, Freeport Sulphur Co.; Earl Perry, drilling superintendent; Lonnie Burnett, driller; R. B. Redden, drilling crewman. Front row, same order: C. W. Monteau and R. L. McDaniel, drilling crewmen; Jack Aldred and Eben Junkin, field superintendent and field engineer, respectively, Baroid Sales Division, National Lead Co.

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equipped with electric logging equipment. A rig for deeper drilling will be added later.

Southeastern to Dallas

Headquarters of Southeastern Drilling Co., Inc., have been moved from Jackson, Miss., to Dallas, where the drilling company will be in closer touch with its drilling operations in the West Texas area. W. W. Gray, superintendent, has been transferred to Midland. W. P. Clements, general manager, will be located at Dallas.

Heasley & Crumpler Drilling Corp., Houston, has contracted with Gem Oil Co. to drill a 5,600-ft. Ellenburger test, 1 Vanderstucken, in Section 60, Block 14, T.W.&N.G. Survey, Sutton County, West Texas. The location is 2 miles from production.

Lynn Drilling Co., Tulsa, is the contractor and joint operator with F. L. Bishop on a 5,100-ft. wildcat test being started in the NE NE SE 4-21n-1e, 6 miles northeast of Perry, Noble County, Oklahoma.

Woods Drilling Co., New Orleans, has moved a rig to a location ¾ mile southwest of production in the Manford district, in Creek County, Oklahoma, where it will drill a test for its own account at 1 Woody, SW SE SE 2-18n-8e.

O'Rourke-Baker Drilling Co., Tulsa, has a rig running for L. A. Edwards on a wildcat test, 1 Keltner, in 30-1n-3e, west of production at the north end of the Tatums pool, in the southwest corner of Garvin County, Oklahoma.

Viersen & Cochran, Okmulgee, Okla., have the contract for Gulf Oil Corp.'s latest well to be started in the Rosenwald pool, Okfuskee County, Oklahoma. It is 2 Timothy, NW SE SE 14-13n-8e.

Kingery Drilling Co., Ada, Okla., is drilling another well for Senora Oil Co. in the north sector of the Bebee pool, Pontotoc County, Oklahoma. The well is 2-B Sutton, NW NW NW 19-5n-5e.

Tilley Drilling Co., Wewoka, Okla., has taken 2 new contracts. One is from Kiska Oil Co. for a well in the North Wewoka pool, Hughes County, Oklahoma. It is 1 Davies-Patterson, SE SW NE 31-9n-8e. The other is from Mercury Oil & Refining Co. for a wildcat in the East Manford area, northern Creek County. The latter is 1 Klintworth, SW SW SW 10-19n-8e.

Ned E. Biffle, Pauls Valley, Okla., drilling contractor, appears to be getting a prolific gas producer in a well he has drilled for his own account on the west side of the East Pauls Valley pool, Garvin County. The well, 1 Stewart, NE NE SW 13-3n-1e, is estimated good for more than 100,000,000 cu. ft. on open flow from 3 zones encountered from 3,807 ft. to 3,863 ft.

R. C. Patton, Wichita, is starting a stratigraphic test for Superior Oil Co. in the area several miles southeast of the small Bow Creek pool, southern Phillips County, northern Kansas. It is 77-22 Steele, NW SE SE 22-5-17.

Penrod Drilling Co., Shreveport, has moved a rig to a wildcat location about 5 miles south of Argo, Caldwell Parish, Louisiana, where it will drill a 6,000-ft. test for Hunt Oil Co., of which it is an affiliate. The location is on the Louisiana Delta Hardwood Lumber Co. land in 23-4n-5e.

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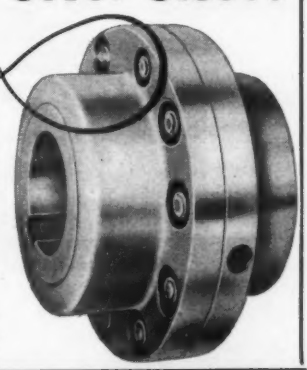

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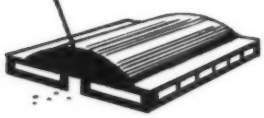

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Exploration and Drilling

Golden Trend Deese Pools Spreading

EXPLORATORY and development activity is still in full swing in the Pennsylvanian third and fourth Deese sands in Oklahoma's Golden Trend field of Garvin and McClain counties. It has been over 4 years since Globe Oil & Refining Co. and Vickers Petroleum Co. 1 Gibson in 3n-2w, drilling for structural oil in the Simpson formation, found commercial production in the third Deese sand to open Southwest Antioch; however, Golden Trend's third and fourth Deese reservoirs are still far from being completely exploited. The rapid and extremely successful wildcatting program and concurrent development of proven areas that followed Globe-Vickers' stratigraphic-trap discovery had production trends well established by the end of the following year, 1947. The years 1948 and 1949 saw the closing of gaps between Garvin County pools along the Deese sea shorelines and the establishment of the updip limits of production for the Gibson (third Deese) and Hart (fourth Deese) sands, both of which feather out against the truncated older rocks of the Pauls Valley uplift.

Today Deese production extends essentially without a break over an area 25 miles long and 5 miles wide at its present maximum width. The narrower portions of the pools in Garvin County are being constantly widened westward toward the outlying islands of Deese production such as Southeast Erin Springs and North Foster areas. At the northern and northeastern edges of present Golden Trend Deese production in McClain County drilling is extending productive outlines basinward and edging toward Southwest Wayne pool.

There are currently about 50 Deese-bound holes being drilled in Golden Trend field. Nearly every one of these holes is on the basinward edge of productive outlines and some are stepouts of several locations. The present concentration of activity in the Deese sands is centered around Sections 27 and 34 in 4n-3w near where W. E. Anderson and Phillips Petroleum Co. recently dually completed their 1 Rill, NE NW 34-4n-3w, for 125 bbl. condensate from the fourth Deese and 135 bbl. 42°-gravity oil from the third Deese through ¼-in. chokes. This was the linking well between prior Deese production outlines for Southeast New Hope area, 1½ miles to the north, Southwest Maysville area, 1 mile to the east, and Southwest Antioch area, 1½ miles to the southwest. Locations between this well and the other three areas are booked nearly solid and there are already seven drilling wells in the two sections.

The water level in the third Deese is reasonably well established in Garvin County but no water has been found in the deeper fourth Deese, which normally comes in bearing condensate about where the third Deese goes to water. Farther downdip the fourth Deese carries oil. The sands of both the third and fourth Deese zones are lenticular so that there are lean and dry areas within established productive outlines. However, the gas, condensate, oil, and water levels, where known, have proven surprisingly consistent.

The theme of this article has been restricted to the lower Deese sand pools of Golden Trend, but readers not familiar with this area must not be left with the impression that only the lower Deese sands have been found productive in the field. In the Katie area of the field a Layton pool is currently being developed. East of the southern portion of the main body of the field upper Deese sands are producing at East Brady, Northeast Roady, and North Hoover pools. The Hunton is produced at Southwest Wayne and in the northern portion of Golden Trend where there is also a sprinkling of Viola wells. Simpson production, especially from the Bromide and Oil Creek formations, predominates in the Maysville and Lindsay areas where fault planes have trapped oil in five Simpson formations. A Southwest Maysville well recently found the Arbuckle productive to add another name to the almost complete sequence of oil-bearing strata in the region.

Philip C. Ingalls.

HIGHLIGHTS OF WEEK'S DEVELOPMENTS

WEST TEXAS.—Completion has been made at Rutherford & Heep 1 John Davis, Borden County discovery in 68-25-H&TC, between Von Roeder and North Vincent fields. The well flowed 225 bbl. of oil a day through 3/16-in. choke, natural, from reef pay at 6,766-81 ft. Standard-Fryer 1 Allen, 76-20-Lavaca Navigation Survey, southwest Scurry County wildcat, reported the Strawn top at 7,290 ft., or minus 4,996 ft. The top was correlated 135 ft. high to the same marker at Standard Oil Co. of Texas 1 Dunn, Pennsylvanian discovery in northwest Mitchell County.

SOUTHEAST NEW MEXICO.—In northeast Lea County, McAlester Fuel Co. 1-A Brownfield, NW NE 24-12s-37e, was drilling ahead to the Devonian. The well has shown for discovery production in the Wolfcamp at 9,366-9,738 ft., and in the Pennsylvanian from 9,781-10,327 ft. A test from 10,183-10,327 ft. recovered water blanket and 5,766 ft. of oil, which unloaded when pipe was pulled. Flowing bottom-hole pressure was 1,600 psi. Recovery from a test at 10,330-10,412 ft. was water blanket, 470 ft. of oil-cut mud, and 406 ft. of salt water. Nearest production is Denton field, 15 miles south, which produces from the Permian, Pennsylvanian, and Devonian.

ROCKY MOUNTAIN AREA.—Trigood Oil Co. estimates its 1 Couch (Merino, Colorado, discovery) good for 500 bbl. of oil daily from the Dakota. Far West Oil Co. and Hancock Oil Co.'s 1 State, Dakota sand discovery at South Glenrock, Wyoming, is flowing 7 bbl. of oil per hour.

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Permian Basin

Terry County Strike Tests, Drills Ahead

MIDLAND.—Amerada Petroleum Corp. 1 N. W. Willard, NE NW 6-C37-PSL, southern Terry County Wolfcamp discovery, found additional pay in that section as well as the water table, and was drilling ahead. Original objective of the test was 12,000 ft., or to the Ellenburger.

The 1 Willard first flowed 144 bbl. of oil in 4 hours on a 5-hour drill-stem test from 8,480-8,507 ft. On its second test, from 8,507-47 ft., gas came to the surface in 8 minutes and oil in 1 hour and 22 minutes. In 4 hours it flowed 108 bbl. of around 43°-gravity oil through ⅝-in. bottom-hole choke. There was no formation water.

Operators then cored ahead from 8,547-97 ft., recovering limestone tentatively identified as similar to the pay section of Anderson-Prichard's 1 Bevers, Pennsylvanian reef discovery some 6 miles to the northwest. On a test from 8,547-97 ft. recovery was 823 ft. of oil, 243 ft. of oil and gas-cut mud and 144 ft. of muddy salt water. According to field sources, the section between 8,547-97 ft. was believed to be reef. It was drilling ahead at last report.

Amerada staked locations for two offsets to its new discovery. The 2 Willard, scheduled to 9,000 ft., was located 660 ft. out of the northwest corner of 6-C37-PSL, which is a west offset to the discovery. Location for an east offset was made as 1 W. O. Miller, NW NE of Section 6. It was also a 9,000-ft. test.

Vickers Petroleum Co., Inc. and Norwood Drilling Co. 1 J. R. Canning, NE SW 142-25-H&TC, 3½ miles north of Von Roeder field, found production in a reef limestone thought to be the Cisco of the upper Pennsylvanian. A drill-stem test from 5,896-5,920 ft., open 30 minutes, had gas in 6 minutes and oil in 17 minutes. It was allowed to flow for 13 minutes, making an estimated 30-40 bbl. a day. Recovery in the pipe was 3,000 ft. of oil with no water. Operators cored ahead 5 ft., recovering dolomitic lime with good oil stain. Operators ran electrical surveys and prepared to set casing for production tests. Production in this area is around 7,100 ft. in the lower Canyon, and around 6,700 ft. in the Sharon Ridge Canyon area, about 4 miles to the southeast. Two miles southwest of the field, Rutherford-Heep 1 John Gilmer Davis, possible reef discovery, below the water table in the Von Roeder wells, ran tubing to 6,758 ft. where it flowed an estimated 25 bbl. of oil an hour through ¾-in. choke. Flowing pressure was 950 pis. Total depth was 6,781 ft.

Sunray Oil Corp. 4 W. L. Wilson, 36-31-3N-T&P, 1¾ miles northwest of production in East Vealmoor Canyon field of southeast Borden County, was drilling ahead at 7,208 ft. in Pennsylvanian limestone. A drilling break was encountered at 7,140 ft. A 2-hour drill-stem test from 7,137-73 ft. recovered 140 ft. of salt water. George Brown 1 Brannon, Pennsylvanian discovery or extension 1½ miles south of the same field, flowed 158 bbl. of oil in 8 hours through 18/64-in. tubing choke, from open hole at 7,325-86 ft., following a 500-gal. mud acid treatment and 3,500 gal. of regular acid. Operators continued flowing to clean and test. Top of the limestone section was placed at 7,300 ft., or minus 4,763 ft. Total depth was 7,386 ft. Location is SW SW 18-27-H&TC on the Howard County side.

In Runnels County, Jerry Rosenberg and others 1 Ray V. Willis, NE NE Section 437, G. Hancock Survey, 6 miles southwest of Lawn, recovered 1,227 ft. of oil and 240 ft. of heavily oil and gas-cut mud on a 3½-hour drill-stem test in sand from 2,655-90 ft. Top of the sand was 2,667 ft. Seven-inch casing was set at 2,672 ft. and tests started in open hole from 2,672-90 ft.

Completion test was reported at O. W. Killam 1 W. W. Early, Section 346, BBB&C Survey, 7 miles southeast of Winters, from perforations in the Gray sand at 3,979-90 ft. The well rated a daily flowing potential of 235.8 bbl. of 44°-gravity oil.

WEST TEXAS (DISTRICTS 8 AND 7-C) SUCCESSFUL WILDCATS

Kimble County: J. D. Davis 1 Mrs. W. Faulkner, 2,444 ft. from E, 644 ft. from N lines, 19-A-GWT&P, east central part of county, TD 2,922 ft., elev. 1,964 ft., Strawn pay 2,910 ft., pumped 96 bbl. of 29.8°-gravity oil in 12 hr.

Terry County: Anderson-Prichard Oil Corp. 1 H. C. Bevers, NE NE 39-DD-John H. Gibson Sur., 6 mi. NW Adair field, TD 9,811 ft., PB 9,805 ft., elev. 3,277 ft., Pennsylvanian reef 9,705 ft., pay 9,710 ft., perf. at intervals from 9,712-9,805 ft., flowed 2,280 bbl. of 42.5°-gravity oil a day, 1-in. opening on tubing, GOR 470 cu. ft., IP 190 psi., potential based on natural flow of 570 bbl. in 6 hr.

WEST TEXAS (DISTRICTS 8 AND 7-C) WILDCAT FAILURES

Crockett County: H. E. Chiles, Jr. 2 Clara Couch, SE SE NE 15-ST-GC&SF, twin well to Glasco 1 Couch, 9 mi. S Vaughn field, dry, TD 1,255 ft., show of gas 905 ft.

Ira Glasscock 1 W. L. Hobbs & Boosy, NE NE NE 3-GG-H&OB, 12 mi. SE Iraan, dry, TD 2,270 ft., elev. 2,283 ft., oil show 1,065 and 2,042 ft.

Kent County: Aurora Gasoline Co. 1 T. O. Sorelle, 100-98-H&TC, 10 mi. E, 3 mi. S Clairemont, dry, TD 7,005 ft., elev. 1,903 ft., Strawn 6,555 ft., Mississippian 6,675 ft., Ellenburger 6,855 ft.

Pecos County: Shamrock Producing Co. 1 State National Bank, NE SW 17-140-T&St.L. Sur., 6 mi. W Baldridge, dry, TD 1,175 ft.

Reeves County: Ford Chapman 1 Ralph Williams, NE NE 24-56-T3-T&P, 6 mi. SE Chapman field, dry, TD 3,433 ft., elev. 2,966 ft., salt 2,860 ft., brown lime 3,226 ft., Delaware sand 3,260 ft. by samples.

Schleicher County: Skelly Oil Co. 3 Mary

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L. Jackson, NE NE SE 42-LL-TCRR, 5 mi. NW Eldorado, dry, TD 7,209 ft., elev. 2,393 ft., Wolfcamp 4,137 ft., Caddo 6,948 ft., Ellenburger 7,113 ft.

Winkler County: Shell Oil Co. 50 Sealy-Smith, NW SE 24-A-G&MMB&A Sur., 3 mi. NE Monahans, dry, TD 9,488 ft., elev. 2,779 ft., Devonian 8,565 ft., Silurian 8,935 ft., Fusselman 9,150 ft., Montoya 9,417 ft.

SOUTHEASTERN NEW MEXICO

HOBBS.—McAlester Fuel Co. 1-A Brownfield, Lea County wildcat in 24-12s-37e, was drilling ahead below 10,135 ft. A drill-stem test from 9,789-9,871 ft., open 80 minutes, recovered 400 ft. of heavily oil and gas-cut mud. A test from 9,865-10,033 ft., open 1 hour and 40 minutes, with 1,000 ft. of water blanket, recovered the cushion plus 645 ft. of slightly oil and gas-cut mud, on flowing pressure of 925 psi. A 2-hour test from 9,822-10,050 ft. had gas in 17 minutes and recovered 500 ft. of water blanket plus 1,786 ft. of oil, and 218 ft. of oil and gas-cut mud. Flowing pressure was 945 psi., and 1,600 psi. shut in. The prospective Pennsylvanian discovery had tentative top of that formation around 9,700 ft., on elevation of 3,884 ft.

Gulf Oil Corp. 1 Sams-State, 17-15s-33e, was drilling ahead at 11,720 ft. in limestone.

Ohio Oil Co. 2 J. M. Denton, NE SE 11-15s-37e, west offset to the Denton discovery, had total depth at 9,660 ft., plugged back to 9,300 ft. and was testing. After swabbing dry, it was washed with 500 gal. of acid, then swabbed 30 bbl. of oil in 6 hours. After treating with 2,000 gal. at 9,070-9,300 ft., the well flowed 85 bbl. of oil in 10 hours.

South Louisiana

Operators Set Casing In Deep Wildcat

NEW ORLEANS.—Richardson & Bass have set 7-in. casing at 12,598 ft. at their 1-G Albert Ruiz, wildcat test in 36-14s-14e, 4 miles south of Oliver townsite and 7 miles southeast of Kenilworth field, St. Bernard Parish. Total depth of the venture is 12,599 ft.

Superior Oil Co. of California is testing through perforations at 8,896-8,906 ft. at its L-1 Miami Corp., wildcat in 34-13s-5w, 2 miles southeast of Lake Misere, Cameron Parish. Six feet of gas sand were logged at this interval. Total depth is 13,751 ft. with 9⅝-in. casing cemented at 10,203 ft.

Stanolind Oil & Gas Co. has run pipe in its 1 The Lacassine Co., Inc., wildcat in 23-12s-5w, Cameron Parish, ½ mile west of Lakeside gas field. The test was perforated with 40 shots from 10,020-30 ft. and on a 20-minute drill-stem test recovery was 1,710 ft. of salt water and 290 ft. of mud. The hole is bottomed at 11,300 ft. with 7-in. casing set to 10,276 ft.

Union Sulphur Co. has made a gas-condensate well with its 1 Willie Bellard, wildcat 1 mile west of production in South Bayou Mallet field, 27-7s-1e, Acadia Parish. The test flowed 27 bbl. of condensate and 996,000,000 cu. ft. of gas daily on a 9/64-in. choke from perforations at 9,578-96 ft. with tubing pressure of 2,900 psi. Gas-condensate ratio was 36,900-1 and gravity of the production was 54.8°. Total depth is 9,650 ft.

Carter Oil Co. has staked a wildcat location, its 1 Hardtner-Tannehill, 3 miles north and 2 miles east of Holloway in NW NE 6-5n-3e, South Catahoula Lake area, Rapides Parish. Objective of the test is the Wilcox at 6,000 ft. Nearest production is 6 miles east and 1 mile north in Indian Bayou field, La Salle Parish.

SOUTH LOUISIANA WILDCAT FAILURES

Calcasieu Parish: Sun Oil Co. 1 Hampton, 21-10s-12w, dry, TD 10,592 ft.

Cameron Parish: The Texas Co. 1 Edith

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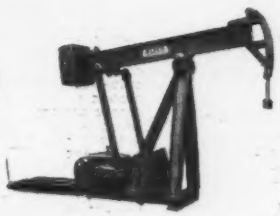

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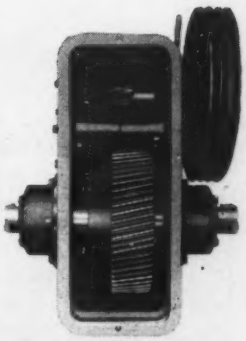

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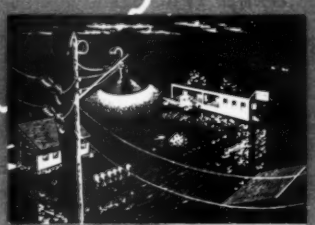

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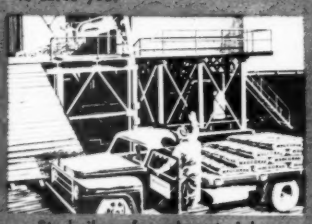

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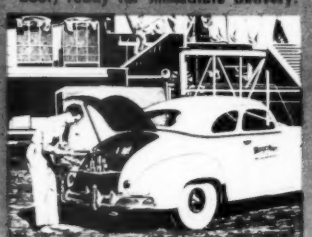

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W. Donner et al, 4-13s-3w, dry, TD 7,510 ft.

Pointe Coupee Parish: Bateman Drilling Co. 1 J. M. Wilson est., 51-5s-8e, dry, TD 10,019 ft.

St. Landry Parish: Sun Oil Co. 1 Teas, 24-4s-6e, dry, TD 11,225 ft.

Washington Parish: Richardson & Bass, 22-3s-11e, dry, TD 11,991 ft.

Southwest Texas

Duval County Gets New Test

CORPUS CHRISTI. — Continental Oil Co. has staked location for a 6,000-ft. wildcat test 7 miles northeast of Sejita, Duval County. Location for the well is on a 3,000-acre lease in Blocks 11 and 12, L. J. Harts Subdivision, F. Cordente Heirs, Santa Cruz de Concepcion Grant, Abstract 173.

Malomar Oil Co. has found its 1 John Brannan dry. Located 5 miles east of North Rincon field and 4 miles south of Sun field, Starr County. it was drilled to 7,301 ft. A core with slight oil odor was cut from 6,623-38 ft. Location is on a 259.7-acre lease, Tract G, Subdivision B, Share 4, El Benadito Grant.

George W. Graham et al are drilling a 7,500-ft. wildcat about 12 miles northeast of Whitsett, Live Oak County. It is their 1 Louis Lupe, located on a 106.5-acre lease, William Cairus Survey 174, Abstract 232.

Houston Oil Co. of Texas and Taylor Refining Co. are drilling below 6,200 ft. on their 1 Felix Koenig, a 9,000-ft. wildcat about 1¾ miles northeast of Deep Rock Oil Co.'s 1 Nagel, gas discovery in DeWitt County. The Koenig is on a 158-acre lease in the Charles Linn Survey, Abstract 309.

Southern Minerals Corp. and Arkansas Fuel Oil Co. are drilling below 6,600 ft. at their 1 Estella Cage, 8,600-ft. wildcat well 5 miles south of Robstown, Nueces County. The test is on an 80-acre lease in George H. Paul Subdivision, Driscoll Ranch.

SOUTHWEST TEXAS SUCCESSFUL WILDCAT

Jim Hogg County: Pontiac Refining Co. 1 Roy Yeager, 657 acre lease, W. R. Newman Sur. 164, 1½ mi. NW Yeager field, TD 3,207 ft., perf. 3,079-82 ft. and 3,089-99 ft., 5½ bbl. of oil daily.

SOUTHWEST TEXAS WILDCAT FAILURES

Atascosa County: Placid Oil Co. 1 Ed F. Eisenhauer & Bros., Diego Perez Sur. A-665, dry, TD 5,391 ft.

Tarpon Oil & Gas Co. 1 E. C. Tuerpe, R. C. Rogers Sur., dry, TD 2,402 ft.

Quintana Petroleum Corp. 2 Guy H. Smith, W. Waggoner Sur. 201½, A-921, dry, TD 2,762 ft.

Bexar County: C. J. Brown 1 Josephine A. Bambler, Adams Stafford & Lysander Wells Sur. 99, A-795, dry, TD 1,526 ft.

Caldwell County: Walter Calmbach, Jr. 1 A. E. Kelley, T. H. Bell & Edward Pettus Surs., dry, TD 2,021 ft.

Duval County: Stice Production Co. 1 A. E. G. Shoeman, Copita Farm & Garden Tracts 3, dry, TD 5,575 ft.

Frio County: Morris Cannan 1 Betty Saunders, J. W. Little Sur. 90, A-1208, dry, TD 4,240 ft.

Lloyd H. Smith, Inc. 1 Ferdinand Biediger, Paul Strother Sur. 136, A-614, dry, TD 3,310 ft.

Jim Hogg County: Killam & Hurd, Inc. 1 C. W. Hellen, Eur. 150, dry, TD 3,631 ft.

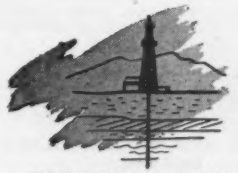
McMullen County: Ryan, Hays & Burke 3 George T. Jamers, James Freal Sur. 155, A-189, dry, TD 6,750 ft.

Starr County: Falcon Seaboard Drilling Co. 1 Pedro Olivares, Porc. 74, 1½ mi. SE El Enuz Ranch, dry, TD 3,010 ft.

Malomar Oil Co. 1 John Brannan, El Benadito Grant, 25 mi. NE Rio Grande City, dry, TD 7,301 ft.

Webb County: L. H. Haring, Jr. & Tiger Minerals, Inc. 1 Servando Benavides, Sur. 698, Cert. 99, dry, TD 2,600 ft.

TOPS IN THE FIELD!



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Rocky Mountain

Denver-Julesburg Prospects Step Up Exploratory Drilling

DENVER.—Wildcat activity is expected to increase considerably with indication of two new discoveries in the northeastern Colorado area of the Denver - Julesburg Basin. Trigood Oil Co. of Casper has rated its discovery at 1 Couch, SE SE SE 10-6n-54w, as a 500-bbl. daily well on pump after a swab test. The well is in the Merino area, Logan County, southwest of the town of Sterling. Dakota sand was topped at 5,090 ft. and the well showed some water in the base of the sand on drill-stem tests. It was drilled to 5,394 ft., total depth, in the Lakota, which showed water. Trigood then plugged back to 5,160 ft. and perforated casing between 5,095-5,112 ft. with four holes per foot. This is one of the thickest Dakota sand sections found in current drilling in this part of the basin. At a wildcat in the Fort Morgan area, Morgan County, Adams Drilling Co. and J. M. Huber Corp. recovered 715 ft. of oil and 670 ft. of water on a 35-minute test in the Muddy sand. Their 2 Lee, SW SE NE 2-2n-57w, tested between 5,445-52 ft., and had gas to the surface in 11 minutes. The well is at 5,478 ft., total depth, and the operator has cemented casing at that depth for perforating and testing thin sand benches in the Muddy. Commercial completion of these wells would make a total of three new commercial pools in the current exploratory drilling campaign in this area, and a total of seven new pools in this basin since discovery by Ohio Oil Co. a year ago of oil in the Sidney, Nebraska, area.

Tests of importance in the basal Green River section on two wells in the Uintah Basin of northeastern Utah are now being conducted. Carter Oil Co. and Stanolind Oil & Gas Co. recovered 4,750 ft. of 30.1°-gravity oil on 3¼-hour test at 2 Ute Tribal, C NW SE 21-1s-1e, second well in the Roosevelt area, Uintah County. This test was between 9,083-9,102 ft. and there was a good blow throughout with gas to the surface in 41 minutes. At this depth the well is still above the basal Green River zone productive in the Rooseveit discovery, ½-mile to the west. The discovery well flowed more than 1,600 bbl. of oil daily on completion. West of Rosevelt, Carter and Stanolind are now testing 1 Unit, C SW NE 6-1s-2w, in the Bluebell area, Duchesne County. This well is at 8,278 ft. and cores have shown saturation in hard tight sands.

Far West Oil Co. and Hancock Oil Co. are continuing tests in the Dakota at their discovery in the South Glenrock area at 1 State 7, SW SW NE 7-33n-75w, Converse County, Wyoming. The well is flowing 7 bbl. of oil per hour after drilling plug. Casing was cemented at 5,858 ft. on top of the Dakota and the well is at 5,880 ft., total depth. It also found Muddy sand oil, and flowed on a 14-minute test in this zone, but this formation was cased off. Successful completion of this well is expected to lead to considerable activity in the area south of the town of Glenrock and east of Big Muddy field.

There were 42 new locations: 18 in Wyoming, 10 in Montana, 6 in western Nebraska, 5 in northern New Mexico, and 1 in North Dakota. Among these, Gulf Oil Corp. made location for a 5,300-ft. Madison test in the East Lamb area, Big Horn County, Wyoming, the corporation's first drilling in the Rocky Mountains in recent years.

WYOMING WILDCAT SUCCESS

Little Buck Creek, Niobrara County: Continental Oil Co. 18 E.L.C.U. "B," SW SW NE 35-36n-64w, 375 bbl. of oil per day, Muddy 3,721 ft., Dakota 3,922 ft., TD 3,965 ft., PB 3,955 ft., perf. Dakota 3,922-48 ft., 208 holes.

WYOMING WILDCAT FAILURE

South Meadow Creek, Johnson County: Pioneer Drilling and Brinkerhoff Drilling 1 Govt., NE NE NE 25-41n-78w, TD 7,715 ft., dry, Shannon 4,245 ft., first Wall Creek 6,260 ft., second Wall Creek 6,679 ft., Dakota 7,560 ft., Lakota 7,638 ft.

COLORADO WILDCAT FAILURES

Firestone area, Adams County: Ed Fisher 1 Finnerty, C NE NW 23-2s-68w, TD 6,001 ft., dry, Hygiene 5,340 ft.

Massadona, Moffat County: Seaboard Oil Co. 63-12-G, NE SW NE, 12-3n-100w, TD 3,860 ft., dry, Frontier 670 ft., Dakota 990 ft., Curtis 1,670 ft., Navajo 1,741 ft., Chinle 2,535 ft., Shinarump 2,770 ft., Moenkopi 2,817 ft., Weber 3,475 ft.

Amherst area, Phillips County: Aladdin Petroleum Co. et al 1 State, C NE SW 36-9n-44w, TD 3,848 ft., dry, Niobrara 2,435 ft., Fort Hayes 2,805 ft., Greenhorn 3,005 ft., first sand group 3,232-3,435 ft., Fuson 3,435 ft., second sand group 3,565 ft., Morrison 3,820 ft.

UTAH WILDCAT FAILURE

Neal Dome, Uintah County: George F. Martin 1 Tissue, NE NW NE 12-4s-20e, TD 590 ft., completed as water well.

NORTHERN NEW MEXICO WILDCAT FAILURE

Lindrith area, Rio Arriba County: Denman Drilling Co. 1 Palmer, C NW SE 1-24n-2w, TD 8,162 ft., dry, Pictured Cliffs 3,418 ft., Lewis 3,448 ft., Mesa Verde 5,103 ft., Menifee 5,208 ft., Point Lookout 5,640 ft., Mancos 5,820 ft., Dakota 7,952 ft.

WESTERN NEBRASKA WILDCAT FAILURE

E. Kimball area, Kimball County: C. D. Neff 1 Rodman, C NE NE, 24-15n-54w, TD 6,028 ft., dry, Niobrara 4,989 ft., Fort Hays 5,224 ft., Codell 5,327 ft., Carlisle 5,341 ft., Greenhorn 5,533 ft., first Dakota 5,835 ft., second Dakota 5,959 ft., third Dakota 6,004 ft.

Mississippi

Extension Try Planned For Rodney Oil Field

JACKSON.—Dorris Ballew, Inc. and Calto Oil Co. are moving in to try for a 1½-mile extension to Rodney field, Jefferson County. The test is the 1 Otis Williams in 5-10n-1w, and is to be drilled to 9,600 ft. or the Lower Tuscaloosa sand.

Roeser & Pendleton, Inc. are starting a confirmation well in Russum field, Jefferson County. It is the 1 Lambert Huff, 17-10n-2e, west offset to Stanolind Oil & Gas Co.'s 1 J. B. Dockery, 27-10n-2e, the discovery well.

Humble Oil & Refining Co. has surveyed location for a confirmation test to Glen Aubin field, Adams County. It is the 1 Charles Rounds, 19-5n-3w, and production is expected around 6,500 ft. in the Wilcox.

Carter Oil Co. has made location for a Travis Peak or Wilson sand test in Pickens field, Yazoo County. It is the 1 Wilson-Wilburn Unit, NW SE 30-12n-3e.

Union Producing Co. 25 Jennie Stevens, SE NE 12-10n-3w, has been completed as an oil well in Tinsley field, Yazoo County.

MISSISSIPPI WILDCAT FAILURES

Adams County: Barnett Serio - Petersen Drilling Co. 1 R. F. Byrnes, 13-5n-3w, dry, TD 6,790 ft.

Hinds County: The Texas Co. 2 C. D. Noble Mineral fee, 35-5n-4w, dry, TD 9,017 ft.

Jefferson County: Pan - Am Southern 1 Mamie Moffett, 62-9n-1e, dry, TD 6,221 ft.

ALABAMA WILDCAT FAILURES

Baldwin County: S. P. Borden-Crow Drilling Co. 1 W. M. Carney Mill Co., 27-2n-4e, dry, TD 6,509 ft.

Clarke County: J. L. Duffy-Woodson Diamond 1 G. W. Clanton, 15-9n-1w, dry, TD 3,908 ft.

Kansas

Ellinwood Area Wildcat Shows for Oil Producer

THE Ellinwood area in Barton County seems assured of another good pool where Alpine Oil & Royalty Co. 1 Kowalski, SE SE NW 20-19-11, flowed 200 bbl. in 2 hours while starting tests of Lansing-Kansas City lime. Top of the section is at 3,078 ft. (—1,289 ft.), with production from a zone in which casing was perforated at 3,080-3,116 ft. Hole had been drilled to the Arbuckle, topped at 3,369 ft. (—1,850 ft.) and penetrated 5 ft. Casing was run to 3,371 ft. Tests of Arbuckle were unsuccessful and hole was plugged back. The discovery is about midway between the North Ellinwood pool, 1½ miles to the northwest, and the Hammeke field to the southeast.

Derby Drilling Co. 1 Johnson, NE NE NW 17-21-12, is opening another new productive spot in North Central Stafford County. With casing perforated opposite a Lansing-Kansas City lime interval at 3,360-66 ft., the well flowed initially at a rate of 6 bbl. of oil per hour with an estimated 5,000,000 cu. ft. of gas per day. Top of the Lansing is 3,234 ft. (—1,379 ft.). Previously, the well had swabbed at the rate of 2 bbl. of oil per hour from Arbuckle lime at a total depth of 3,545 ft. The latter zone had been topped at 3,487 ft. Although only ¾ mile north of the Mueller pool, the well is separated from that production by a dry hole.

Testing also is under way at another prospective discovery well in the south central part of the same county. It is J. M. Huber Corp. and associates 1 Kachelman, SE SE SW 7-25-13, about 2 miles from nearest production, the Northeast Kipp pool, to the southwest. Drilled out to a total depth of 4,075 ft. in Viola lime, topped at 4,056 ft. (—2,092 ft.), and acidized with 500 gal., the well swabbed 25 bbl. of oil in the first 6 hours.

After three previous attempts to find production in the immediate area, Herndon Drilling Co. appears to have a well in its 2 Hunt, SW SE NW 16-34-1e, 8 miles west of the Padgett pool, nearest production, in Sumner County, in the southern part of the state. In Simpson dolomite topped at 3,999 ft. (—2,810 ft.), and drilled to a total depth of 4,004 ft., the well swabbed at the rate of 8 bbl. of 45° oil per hour for 7 hours. Gas flow was estimated at 150,000 cu. ft. per day. Hole is open below 4,000 ft.

Another Sumner County wildcat, The Texas Co. 1 Hobbisiefkin, SW NE SW 3-35-3w, deepened after encountering promising oil and gas showings in both the Kansas City lime and the Mississippian, has found additional prospects of production in Simpson sand. A drill-stem test at 4,751-61 ft. in this sand, topped at 4,740 ft. (—3,613 ft.), yielded 135 ft. of distillate in the pipe break-down. Tool was open 2 hours, with gas showing within 12 minutes. Indicated bottom-hole pressure was 1,730 psi.

Extension of the Russell pool, Russell County, ¾ mile north and east to the edge of the Russell townsite, is virtually assured by Lewis Drilling Co., whose 1 Streck, SW SE NW 26-13-14, swabbed an average of 8 bbl. of oil per hour while testing Arbuckle lime. Top of the pay is 3,265 ft. (—1,433 ft.) with casing at 3,272 ft., leaving 3 ft. of open hole to total depth.

Sam K. Pack has reopened the abandoned Fleming area in Elk County, in the southeastern part of the state. His 1 Rader, SE SE SE 8-29-9e, pumped 50 bbl. of oil daily on potential tests. Production is from Arbuckle lime at 2,656-60 ft. Only the bottom 6 ft. of pay is open.

KANSAS SUCCESSFUL WILDCATS

Graham County: Heathman 1 Abiram, NE NE SW 4-10s-21w, pumped 330 bbl. of oil per day from Arbuckle topped at 3,870 ft., TD 3,873 ft., elev. 2,302 ft., anhydrite 1,769 ft., Topeka 3,296 ft., Lansing 3,539 ft., Arbuckle 3,870 ft.

Seward County: Cities Service 1 Baughman, C Section 30-32s-32w, 6,540,000 cu. ft. of gas from Krider topped 2,564 ft., TD 2,695 ft., elev. 2,772 ft.

Stafford County: Petroleum, Inc. 1 Brown "B," NE NE NW 7-21s-13w, 118 bbl. of oil per day from Lansing topped at 3,329 ft., TD 3,654 ft., elev. 1,913 ft.

KANSAS WILDCAT FAILURES

Barton County: Lynn 1 Munns, NW SW NE 23-17s-13w, elev. 1,843 ft., dry, TD 3,389 ft.

Butler County: Gross Supply 1 Corbin, NE NE NE 32-26s-4e, elev. 1,249 ft., dry, TD 2,868 ft.

Marhenke et al 1 Varner, NW SE NW 31-27s-5e, elev. 1,337 ft., dry, TD 2,845 ft.

H & M Drilling 1 Corneilson, NW NW NW 30-29s-4e, elevl. 1,200 ft., dry, TD 2,345 ft.

Bennett & Abel 1 Merville, CNL NW SE 2-26s-3e, elev. 1,282 ft., dry, TD 2,735 ft.

Ellis County: G. M. R. Oil 1 Jensen, SE SE SW 35-11s-19w, elev. 2,136 ft., dry, TD 3,730 ft.

B & R Drilling 1 Haller, NE NW NE 10-11s-18w, elev. 1,961 ft., dry, TD 3,571 ft.

Kingman County: Beardmore et al 1 Morhouse, NW NW NW 25-28s-5w, elev. 1,382 ft., dry, TD 3,907 ft.

Marion County: Russell and Murfin 1 Spangler, CSL SE NE 35-22s-3e, elev. 1,449 ft., dry, TD 3,110 ft.

McPherson County: Jackson et al 1-A Lovett, NE NE SE 14-18s-4w, elev. 1,463 ft., dry, TD 3,793 ft.

Osborne County: Sohio 1 Schloh, NW NW SE 15-10s-15w, elev. 1,835 ft., dry, TD 3,529 ft.

Rooks County: Lynn 1 Perkins, NE NE SE 26-7s-20w, elev. 1,987 ft., dry, TD 3,510 ft.

Heathman 1 Towns, SW SW SW 4-10s-20w, elev. 2,190 ft., dry, TD 3,791 ft.

Sedgwick County: Sohio 1 Erdwein "B," NW SE NW 2-26s-2e, elev. 1,361 ft., dry, TD 3,383 ft.

Stafford County: Finston & Murfin 1 Norris, NE NE NE 30-22s-13w, elev. 1,905 ft., dry, TD 3,950 ft.

Armer 1-A Stromer, SE SE NE 22-24s-14w, elev. 1,942 ft., dry, TD 4,275 ft.

EASTERN NEBRASKA WILDCAT FAILURES

Richardson County: Peters 1 Oswell, SE NW SW 15-2n-14e, elev. 1,142 ft., dry, TD 3,315 ft.

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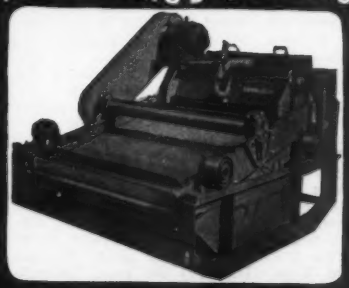

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Oklahoma

Logan County Wildcat Producers from Wilcox

ROBERT M. JORDAN is opening another promising new pool in Logan County where his 1 Carum, W½ SW NW 33-16n-1w, 3 miles south and 6 miles east of Guthrie, flowed 116 bbl. of oil through 16/64-in. choke in a 4-hour production test. Production is from what has been called the first Wilcox sand, in which casing was perforated at 5,790-96½ ft. When casing was perforated the well filled 2,500 ft. with oil in the first hour. Total depth is 5,910 ft. with 5½-in. casing at 5,865 ft. The well previously had shown for a good producer in Bartlesville sand, logged at 5,310-88 ft. Prior to testing the Wilcox casing was perforated in the shallower formation at 5,340-48 ft. On a brief test of this zone, the well flowed oil but no gage nor estimate was made. First Wilcox was topped at 5,782 ft. Second Wilcox, topped at 5,900 ft., was dry.

Gulf Oil Corp. and Faultine Oil Corp. have completed their 1 Wilson Estate, NE NW NE 27-10n-1e, east of Stella, in northeastern Cleveland County, opening the East Stella pool. During a 6-hour flow through 12/64-in. choke, the well produced 247 bbl. of oil, and is credited with an initial production of 988 bbl. per day. Production is from the Trenton-Dolomite zone at 6,069-6,116 ft., with casing perforated at 6,072-78 ft. and 6,109-19 ft. Prior to testing, hole had been plugged back to 6,139 ft. from a total depth of 6,286 ft. in second Wilcox sand, topped at 6,242 ft. The latter sand was dry. Drilling is being started at a north offset, 1 Ginter, NE SW SE 22-10n-1e, to confirm the discovery.

Davon Oil Corp. and Sunray Oil Corp. 1 Kelly, SW SW SW 27-25n-4w, which opens the Salt Fork Southwest pool in Grant County, has been completed pumping 18 bbl. net oil with approximately 25 bbl. of water per day. Production is from Wilcox sand with casing perforated at 6,006-27 ft. and 6,050-68 ft. Total depth is 6,165 ft. with casing at 6,158 ft.

Dick Wegener 1 Steelman, NW SW NE 23-1n-7w, prospective discovery well in the area 3 miles northeast of Duncan, Stephens County, flowed at the rate of 2 bbl. of 42° oil per hour with an estimated 2,000,000 cu. ft. of gas per day while testing Pennsylvanian sand through casing perforation at 6,018-28 ft. In a previous test of a lower sand, in which casing was perforated at 6,879-89 ft., the well swabbed at the rate of 40 bbl. of 55° distillate, 10 per cent water, per day. Testing continues.

A wildcat located a mile south of the southeast extension area of the Velma pool, in Stephens County, has encountered promising oil and gas showings. It is Pray & Morgan 1 Morrison, NE NE NE 9-2s-4w, south of the Alma townsite. Sand, topped at 4,768 ft., had staining and odors in samples. A drill-stem test at 4,760-80 ft. yielded 15 ft. of gas-cut mud. A test of a slightly lower interval at 4,776-4,800 ft. got 60 ft. of mud, 270 ft. of oil and gas-cut mud and 180 ft. of gas-cut salt water. Operators are drilling ahead.

OKLAHOMA SUCCESSFUL WILDCATS

Grant County: Sunray et al 1 Kelley, SW SW SW 27-25n-4w, pumped 18 bbl. of 47°-gravity oil per day from Wilcox at 6,027-47 ft., TD 6,168 ft., elev. 1,062 ft., Layton 4,281 ft., Checkerboard 4,640 ft.,

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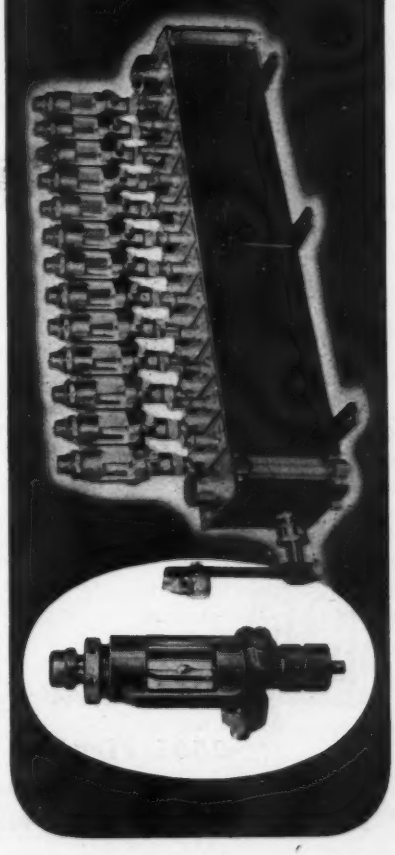

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Major County: Mazda Oil 1 Haskins, NE SW NE 35-22n-10w, extension discovery, flowed 210 bbl. of oil per day from Manning at 6,767-6,811 ft., TD 7,178 ft., elev. 1,282 ft.

Mazda Oil 1 Boehs "B," NE NE SE 35-22n-11w, extension discovery, flowed 180 bbl. of oil per day from Manning at 6,778-6,928 ft., TD 7,172 ft., elev. 1,281 ft.

Pawnee County L. L. Welker 1 Welker, SW NE SE 23-23n-5e, pumped 8 bbl. of oil per day from Wilcox 3,324-54 ft., TD 3,713 ft., elev. 802 ft., Big lime 2,539 ft., Mississippian 3,072 ft. Arbuckle 3,544 ft.

OKLAHOMA WILDCAT FAILURES

Beckham County: Decem Drilling 1 W. F. Hill est., C SE SW 11-9n-21w, elev. 1,757 ft., dry, TD 12,095 ft.

Carter County: Stanolind Oil & Gas 1 Brigance, SW SW SE 32-3s-3w, elev. 1,070 ft., dry, TD 9,344 ft.

Cotton County: Bundy & Ketelsen 1 Weempi, SE NW SW 12-5s-13w, elev. unknown, dry, TD 1,832 ft.

Garvin County: Edwards et al 1 Prince, NE SW SW 31-1n-2w, elev. unknown, dry, TD 300 ft.

Jackson County: Sun Oil 1 Hullett, SW SW NE 33-1s-22w, elev. 1,477 ft., dry, TD 7,507 ft.

Jefferson County: Guinn 1 Linton, SW SW SW 7-7s-6w, elev. unknown, dry, TD 760 ft.

Lincoln County: Wilson 1 School land, SE SE NW 36-13n-5e, elev. unknown, dry, TD 3,351 ft.

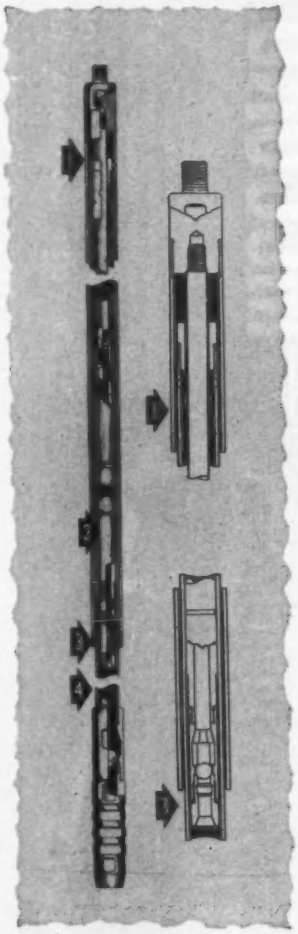
Falcon-Seaboard 1 Marshall, SE SE NE 28-15n-4e, elev. 1,019 ft., dry, TD 3,950 ft.

Love County: Davenport 1 Draughon, SE SE SE 21-6s-2e, elev. unknown, dry, TD 746 ft.

Osage County: Steelman 1 Osage, SE SE NE 7-22n-7e, elev. 951 ft., dry, TD 2,976 ft.

Pottawatomie County: Alpha Petroleum 1 Fundis, SE SE NE 5-6n-3e, elev. 995 ft., dry, TD 5,080 ft.

Seminole County: King and Reeves 1 Haning, NE NE SW 21-10n-7e, elev. 983 ft., dry, TD 3,766 ft.



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Michigan

Two Basin Wildcats Command Attention

MOUNT PLEASANT.—The Michigan oil industry was watching developments at two Isabella County wildcat oil tests this week. One well was being completed in the Traverse where flowing production was unexpectedly logged a week ago, and the other was being acidized in the Dundee, most common producing horizon in the Michigan basin.

On the west edge of the Mount Pleasant city limits, Franklin T. Rand and C. W. Collin logged a Traverse oil pay at their 1 Albar, NW NW NW 20-14n-4w, Union Township. This wildcat, originally scheduled to test the Dundee, was drilled into a Traverse oil pay at 3,193-95 ft. which filled the hole with oil in about 30 hours after top of lime was found at 3,118 ft. The well flowed one head of 65 bbl. in 45 minutes, 38 hours after pay was first tapped. Completion of this well was delayed by a caving hole and failure of 5-in. casing to run to bottom. Casing is now set on a packer about 91 ft. from the bottom of the hole at which point the pipe failed to go. With as much as 25 ft. of gray shale cave in the bottom of the hole, the test has headed up and flowed about 30 bbl. on an average of every 12 hours since July 16. Tubing and further tests were scheduled to be run.

The wildcat checked in structurally low on upper markers, but a thinning of interval was reported between the top-hole correlation points and the Traverse. Merrill Drilling Co. and I. W. Hartman are associated with Rand & Collin in this test. Cities Service Oil Co., The Superior Oil Co., Sun Oil Co., The Chartiers Oil Co., Turner Petroleum Corp., and Leonard Oil, Inc., own acreage around the well.

In Wise Township, Isabella County, Union Development Co. logged a potential commercial Dundee oil pay at the 1 Rank, SE SE SW 13-16n-3w. Dundee was topped at 3,744 ft. and hole carried 600 ft. of oil in 16 hours, natural, at 3,787-90 ft. The hole is bottomed out at 3,796 ft. The well swabbed 5 and 12 bbl., natural, on successive tests, and was acidized with 1,000 gal. Tthe 1 Rank is located about 3 miles east of Wise (Dundee) oil pool, Isabella County, and about 8 miles northwest of Jerome field, Midland County. The pay section appeared to be comparable with the Dundee pays in these other two fields in the same general area.

MICHIGAN WILDCAT FAILURES

Allegan County, Allegan Township: Sheldon-Stewart Co. 1 Holthof, NW SE NE 14-2n-13w, Traverse 1,449 ft., dry, TD 1,485 ft.

Otsego Township: James J. McGerry, Tr. 1 Brooks, SE NW SE 5-1n-12w, Traverse 1,438 ft., dry, TD 1,441 ft.

Valley Township: The Ohio Oil Co. CT-A-48 U. S. A., NW NE SW 28-2n-14w, Traverse 1,332 ft., dry, TD 1,342 ft.

Bay County, Fraser Township: Swan-King Oil Co. 1 Price, NW SW NE 10-16n-4e, Dundee 2,910 ft., dry, TD 3,012 ft.

Mason County, Riverton Township: Walhall Oil Co. 1 Witte, SW SW SW 8-17n-17w, Monroe 2,359 ft., dry, TD 2,423 ft.

Montcalm County, Belvidere Township: Chapman Oil Co. and Union Development Co. 1 Hutchinson, SW SE NE 36-

CHAPTER THREE in the Fascinating Story of the Search for Oil

In 1897 The establishment of rational techniques of prospecting really began with the acceptance by the industry of geology as a guide to the study of oil and gas deposits. By 1900, geology had begun to secure a foothold in the industry. Edwin T. Dumble, formerly state geologist for Texas, joined the Southern Pacific companies as a geologist in 1897. The organization founded by him is one of the oldest geological departments having to do with oil in the United States. About 1913, however, geology was definitely accepted as a guide to prospecting. This year marked the permanent establishment of geological departments in the mid-continent and the beginning of intensive surveys and examinations which, through the various changes and developments of new techniques, continue to the present time. From E. DeGolyer's book, *"The Development of the Art of Prospecting."*

In 1950 General crews work as a wing of geological departments under direction of the client's geologists. In most cases, it is the responsibility of today's trained geologist to select the site to be surveyed by modern seismograph methods in order to locate conditions favorable to finding new oil reserves. From data compiled by capable crews working with modern equipment specifically designed for current exploration problems, the geologist then makes the key decision of whether to recommend the investment necessary to drill the test well. For more than a decade, geologists and operators alike have relied on General's experienced crews to help lead the way to their next discovery well. And today, General is better equipped than ever!

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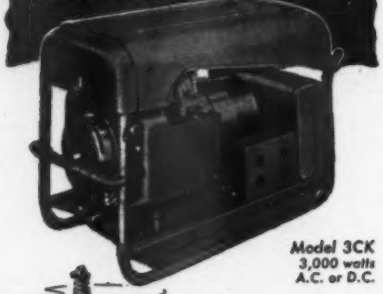

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12n-7w, Dundee 3,485 ft., dry, TD 3,493 ft.

Newaygo County, Troy Township: M. B. Belden 2 Fawcett, NE NE SE 28-16n-14w, Traverse 2,164 ft., dry, TD 2,177 ft.

Oceana County, Claybanks Township: Roxie Oil Co., Inc. 1 Hatfield et al, NE NE SE 8-13n-18w, Traverse 1,648 ft., dry, TD 1,664 ft.

Eastern Texas

Wood County Deep Wildcat To Test Salt Dome Flank

DALLAS.—Plans for a deep test in Wood County, 3 miles southeast of Hainesville, and on the southwestern flank of the Hainesville salt dome, were being made by C. S. Gainer, Jr., of Houston, according to reports. The wildcat, which is expected to get under way soon, was expected to be on the J. C. Judge 1,476-acre tract in the J. Brewer Survey. Location is on a Magnolia Petroleum Co. farmout. Companies said to be supporting the venture included Gulf Oil Corp. and Sells Petroleum Co. Contract depth would be around 10,500 ft., which is expected to explore the Woodbine.

In Smith County, M. E. Robinson staked location for the 1 Robinson-Smith, an 8,000-ft. Paluxy test 2 miles south of Tyler, and located 450 ft. west of the most easterly west line and 100 ft. south of the north line of the M. M. Long Survey. Drill-site is 1,500 ft. southwest of Bobby Manziel 1 John L. Campbell, discovery well.

Testing continued at The Texas Co. 1 Clarke, wildcat 2 miles southwest of Pine Hill in eastern Rusk County. Wash water and salt water with a light gas show was recovered from perforations at 7,248-68 ft. Earlier tests at 7,546-76 ft. and 7,610-42 ft. had about the same recovery. Operators were to perforate higher in the Pettit section The same operators' 1 Fannie Sorrells, Thomas William Survey, 1 mile southwest of Mt. Enterprise, was coring ahead at 7,602 ft. in shale and lime.

A 2-mile south stepout test to South Bolivar field was staked by J. M. Hickey & Sons, Fort Worth, as the 1 J. E. Lutz. Location is 330 ft. from the most southerly north line and 3,696 ft. from the most easterly east line of the J. Ruddell Survey, A-1061. Projected depth was 3,000 ft. with rotary. It is 2 miles south of the Bolivar townsite.

One mile south of Sandusky, in Grayson County, A. O. Phillips and The Texas Co. 1 F. W. Reast, E. L. Stickney Survey, was drilling at 6,726 ft. in shale and lime. A 1-hour drill-stem test from 6,678-88 ft. recovered 630 ft. of gas in the pipe and 20 ft. of heavily oil-cut mud.

EAST TEXAS (DISTRICTS 5, 6 AND 6-P) WILDCAT FAILURES

Freestone County: Humble Oil & Refining Co. 1 Ficklin & Williams, A. M. Sloan Sur., 3 mi. NW Fairfield, dry, TD 4,362 ft., elev. 412 ft.

Grayson County: Kay Kimbell 1 Elmer Mitchell, Aaron Burleson Sur., A-61, 2 mi. E Sherman, dry, TD 3,500 ft., elev. 731 ft., sand with oil show 3,335 ft.

Hunt County: M. H. Oil Co. 1 Jas. B. Kirkland, Wm. Aiken Sur., 6 mi. NE Merit, dry, TD 2,792 ft., elev. 623 ft.

Limestone County: Dave Kelton and W. W. Lincoln 1 Retta, George and M. Murphy, P. Varella Sur., 4½ mi. W Mexia, dry, TD 1,788 ft., elev. 510 ft., Nacatoch 788 ft., Wolf City 1,650 ft.

Wood County: Kemp Drilling Co. 1 Lee Kelly, James B. Grant Sur., A-242, 7 mi. SE Quitman, dry, TD 6,515 ft., base chalk 5,550 ft.

California

Prospective Discoveries Highlight Week's Activity

LOS ANGELES.—In the Cuyama Valley area, the bright spot of an otherwise disappointing week was showings made by Hancock Oil Co.'s 44-31 Hancock-Bishop. Located in Section 31-32-20e, or about 2¾ miles northwest of Morales field, the test (at last reports) had reached a total depth of 5,900 ft. It reportedly an oil sand at 5,822 ft. and was still in the sand at 5,855 ft. The pay was said to be "loaded" with oil but apparently was of extremely low permeability.

Previously, at the 2,290-ft. level, the wildcat had cored an oil sand which scouts said might be good for commercial production. Also at the 5,700-ft. level another show was encountered. A drill-stem test of the latter zone, at 5,664-5,740 ft., yielded a steadily decreasing gas flow during the 1-hour test period. When drill-pipe was pulled some 100 ft. of gas-cut mud was recovered.

The second interesting wildcat was in the Huron area of Fresno County, approximately 15 miles east of East Coalinga production. At last reports General Petroleum Corp. was preparing to run 7-in. casing in the 13,621-ft. hole, its 44-14 Boston Land Co. Field reports credit the test as being a prospective discovery, but the operator has released no data other than the total depth figure. Location of the venture is in Section 14-20s-18e.

Clayton pool of Morales field received its first setback at Richfield Oil Corp.'s 76-10 O'Day, on the southeast flank. Located about ½ mile southeast of the discovery well for the 2,200-ft. Morales sand, the outpost was dry at 2,242 ft. Some ¾ mile southwest of the discovery, Peak Oil Tool Service 81-16 Stone apparently had missed the fault block and was drilling below 3,500 ft.

In the Superior area, ½ mile northeast

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of Morales production, Superior Oil Co. is said to have completed its 17-2 U. S. Government as a 165-bbl.-per-day pumper. The well was a north offset to the pool's discovery. The company has released only meager data on both wells.

In the Mattole River Valley of Humbolt County, Independent Exploration Co. found its 1 Roscoe, Section 34-2s-1w, dry at 4,420 ft., and staked a new test in Section 36, 2½ miles to the east.

In the Ventucopa area of southeastern Cuyama, Ventura County, Richfield has staked location for its 2 Apache unit. The test falls 3¼ miles southeast of the 1 Apache unit, failure at 10,563 ft. earlier this year, and about ¾ mile northwest of the corporation's 1 Round Springs unit, dry at 4,010 ft.

CALIFORNIA UNSUCCESSFUL WILDCATS

Fresno County, Huron area: Triumph Oil Co. 3 Farrand, 34-20s-18e, 11 miles E Guijarral Hills field, dry, TD 9,500 ft., elev. unknown.

Humbolt County, Mattole River Valley area: Independent Exploration Co. 1 Roscoe, 34-2s-1w, dry, TD 4,420 ft., elev. 338 ft.

Kern County, Antelope Valley: Amerada Petroleum Corp. 1 Still, 3-26s-17e, dry, TD 4,262 ft., elev. 1,073 ft.

Tejon Hills area: R. B. Jackson & C. E. Zillgitt 4 R. B. Jackson, 13-11n-18w, dry, basement 253 ft., TD 505 ft., elev. 1,100 ft.

Los Angeles County, Puente area: Jergins Oil Co. 1 Handorf, 1-2s-11w, dry, TD 7,264 ft., elev. 300 ft.

R. M. Peck & Sons 1 Layaye, 33-1s-10w, dry, TD 1,160 ft., elev. 421 ft.

Newhall area: Provost & Associates 1 Pro-Trana, 25-4n-16w, dry, TD 1,120 ft., elev. 1,539 ft.

San Luis Obispo County, East Cuyama Valley area: Richfield Oil Corp. 1 Caliente unit, 18-10n-24w, dry, TD 4,722 ft., elev. 3,471 ft.

North Cuyama area: Richfield Oil Corp. 2-76-10 O'Day, 10-11n-28w, dry, TD 2,242 ft., elev. 2,503 ft.

Santa Barbara County, Southeast Cuyama Valley area: Rothschild Oil Co. 1 U. S., 11-9n-27w, dry, Dibblee sand 2,074-2,250 ft., TD 4,396 ft., elev. unknown.

Texas Gulf Coast

Sun Oil Co. Venture Gets Big Gas Flow

HOUSTON.—Sun Oil Co. has opened up a new gas area in the Oyster Bayou section of Chambers County with its 31 Felix Jackson. The strike flowed 38,000,000 cu. ft. of gas daily on open flow potential with a tubing pressure of 3,135 psi. Production is from perforations at 8,408-21 ft. and total depth of the hole is 10,200 ft. Location is on a 10,142-acre lease, T&NO Survey 124.

Sun had another wildcat operation in the same county, its 1 Brandt, 3 miles southeast of Smith's Point field. at last reports it was drilling below 12,270 ft. The well is located on a 1,113.25-acre lease, Henry Barker Survey, and has a proposed depth of 12,500 ft.

Sinclair Oil Co. is drilling below 3,600 ft. at its 1 Louis H. Schultz, 10,000-ft. wildcat on a 205.75-acre lease, James Tylee Survey, A-550, west flank of New Ulm field, Austin County. Surface casing was set at 2,395 ft.

L. M. Josey et al have made location for a wildcat in South Liberty field, Liberty County. It is the 1 E. W. Pickett on a 12.2-acre lease, M. G. White League, A-117. Scheduled depth is 6,000 ft.

The Texas Co. has staked location for a wildcat in the North Dayton area, Liberty County. It is the 2 J. D. Williams on a 320-acre lease, H&TC RR Survey 123, A-262. Scheduled depth is 7,500 ft.

Russell Maguire is to drill a wildcat 1 mile southeast of Rosalia field and 4 miles north of Driscoll field, Duval County. It will be the C-1 Driscoll on a 320-acre lease, E/2, Section 46, Santa Rosalia Grant, Abstract 467, Sweden Farm Lot Subdivision.

TEXAS GULF COAST SUCCESSFUL WILDCATS

Colorado County: Shell Oil Co. 18 Plow Realty Co., Francis Mayhar Sur. A-400, new pay in Sheridan field, TD 4,615 ft., top pay 5,160 ft., perf. 32 shots 5,160-68 ft., 125 bbl. of oil daily on ½-in. choke, gravity 43.5°.

Jefferson County: Meredith-Clegg & Hunt et al 1 Earl C. Hankamer et al unit, T&NO Sur., Sec. 136, Lot 10, 1 mi. SW Hamshire, 125,000,000 cu. ft. of gas daily and 49 bbl. of condensate per 1,000,000 cu. ft. of gas, perf. 12,607-70 ft., TD 12,809 ft.

Lavaca County: Stanolind Oil & Gas Co. 1 Roeber unit, James Campbell Sur. 2, A-6, new pay in Halletsville field, 128 bbl. of oil daily, perf. 8,408-14 ft., TD 8,486 ft., GOR 1,960-1, TP 1,500 psi., gravity 37°.

TEXAS GULF COAST WILDCAT FAILURES

Bee County: James R. Dougherty 1 Sterling F. Dugat et al, F. B. Malone Sur. A-527, 3½ mi. NW Mineral, dry, TD 7,550 ft.

Chambers County: Placid Oil Co. 1 G. R. Canada, J. T. White Sur. 4, A-402, 8 mi. SW Oyster Bayou field, dry, TD 12,515 ft.

Calhoun County: Brazos Oil & Gas Co. 1 American National Insurance Co., Calhoun Co. Cattle Subd., dry, TD 9,550 ft.

Humble O. & R. Co. 2 Maude B. Taylor, east shore of Lavaca Bay, Juan Maldanado Grant, dry, TD 9,841 ft.

Hardin County: J. C. Chance Well Service,

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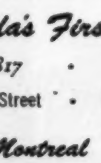

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Inc. 1 Nona Mills Co., I. D. Hamilton Sur. A-249, 10 mi. NE South Lake, dry, TD 10,662 ft.

Karnes County: Jake L. Hamon, Edwin L. Cox, Rowe & Whitaker 1 D. C. Lyons, V. Zepeda Grant, ¾ mi. NW Runge field, dry, TD 6,761 ft.

Kirkwood & Co. et al 1 A. J. Luckett, Tr., S. A. J. Mays Sur. A-212, dry, TD 6,985 ft.

Newman Bros. Drilling Co., Alaska Steamship Co. & Calvert Corp. 1 Jake Rubman, Carlos Martinez Grant, 6 mi. SW Kenedy, dry, TD 7,250 ft.

Live Oak County: The Chicago Corp. & Nueve Oil Co. 3 J. I. Haily, P. Miller Sur. A-277, dry, TD 4,892 ft.

Refugio County: Amerada Petroleum Corp. 1 J. Agnes Hynes, John Malone Sur. A-46, dry, TD 7,596 ft.

Wharton County: Edwin Nielsen 1 Carrie K. Koch, ETRR Sec. 83, A-135, dry, TD 8,030 ft.

Wilson County: Ray Clark & Joe Stelzig 1 Carlos Flores, Bicents Yepada Grant, dry, TD 3,045 ft.

W. R. Quin et al 4 A. C. Oefinger, Hose de la Garza Grant, dry, TD 2,931 ft.

North Central Texas

Stephens County Discovery Gets Mississippian Reef Oil

WICHITA FALLS.—In Stephens County, McElroy Ranch Co. 1 Glenn Taylor, Section 1,538, TE&L Survey, Mississippian discovery 9 miles west of Breckenridge, completed for a calculated daily potential of 220 bbl. of 41°-gravity oil a day, through 11/64-in. choke. Pay section was identified as a Mississippian reef topped around 4,065 ft. on elevation of 1,218 ft. Total depth was 4,158 ft. Previous to completion, two drill-stem tests were made. From 4,065-4,112 ft., open 15 minutes, gas showed in 1 minute which was estimated up to 12,000,000 cu. ft. daily. The second test, from 4,112-37 ft., had gas in 4 minutes, mud in 40 minutes and oil in 45 minutes, which flowed at an estimated 60 bbl. per hour. Flowing pressure was 450 psi.

Stonewall County's Bend conglomerate discovery was ready for completion tests. Roark, Hooker & A. G. Hill 1 C. L. Williams, Section 6, AB&N Survey, 8 miles northeast of Aspermont, made a preliminary flow of 500 bbl. of oil in 15 hours through ¾-in. choke. The first hour, flow was 50 bbl. and the last hour, 44 bbl.

Southern Wichita County gained an extension well at William Herbert Hunt 1 N. R. Temple, semiwildcat 7 miles west of Wichita Falls in Block 13, Palo Pinto County School Lands Survey. Completion was from oolitic limestone at 4,094-4,106 ft., where it pumped 85 bbl. of 42°-gravity oil a day, plus some water. Location is 3,000 ft. northwest of Fain & McGaha's 2-A Parker heirs.

Four miles south of Iowa Park, in the Wichita River bed, Henry Grace Production Co. 2 Wichita River Tract 3, was drilling ahead at 2,590 ft. in shale and lime.

In Haskell County, Pan American Production Co. 1 C. A. Jackson, League 70, Coryell County School Land Survey, 3 miles west of Rule, was swabbing through casing perforations from 5,900-26 ft., making fluid that averaged 10 per cent. Amount of recovery was not disclosed. The section had been treated with 2,000 gal. of acid. Further testing was to include the conglomerate from 5,836-76 ft.

G. E. Kadane & Sons 1 W. V. Weinzapfel, Lot 116, Block 4, Clark & Plumb Subdivision, prospective KMA sand discovery 4½ miles northeast of Burns-Jones field, was waiting on cement after setting 5½-in. casing at 3,797 ft. Shows of oil were reported at 3,800-08 ft.

In Montague County, D. H. Bolin 1 Cato Heirs, wildcat in the F. Robertson Survey, A-620, 11 miles north of Nocona, had 7-in. pipe set at 2,773 ft. and was waiting on cement. A drill-stem test in the Strawn sand at 2,689-96 ft. recovered 2,650 ft. Total depth of 3,267 ft. was 67 ft. into the Ellenburger.

Four miles northwest of Bowie, The Texas Co. 1 Boedecker "B," west offset to its discovery, had stuck drill-pipe at 5,275 ft.

Harvey Drilling Co. 2 LaForce, John Short Survey, A-664, wildcat 10 miles northeast of Bonita, was drilling below 2,562 ft. in shale.

NORTH TEXAS (DISTRICTS 9 AND 7-B) SUCCESSFUL WILDCATS

Baylor County: B. S. & W. Drilling Co. 1 R. G. Quisenberry, Sec. 95, P. L. Leaman Sur., A-264, 4 mi. NW Westover, TD 3,120 ft., elev. 1,285 ft., Canyon lime pay 3,115 ft., pumped 14 bbl. of 32°-gravity oil a day.

Jack County: Cabot Carbon Co. 1 Gladys Norman Adams, A. Pearson Sur., A-1304, 5 mi. SW Bryson, TD 3,913 ft., elev. 1,143 ft., Caddo 3,775 ft., pay 3,852 ft., flowed 114 bbl. of 42°-gravity oil in 6 hr., 18/64-in. choke, GOR 608 cu. ft., TP 625-620 psi., CP 1,050 psi.

Montague County: The Texas Co. 1 J. B. Zetzsche, 660 ft. from SE, 660 ft. from SW lines, Blk. 41, Hill CSL, 2 mi. SE Bowie, TD 6,501 ft., Simpson pay 6,470 ft., flowed 331.21 bbl. of 44°-gravity oil in 12 hr., ¼-in. choke, 64 perfs. 6,470-81 ft.

Stephens County: R. W. Fair et al 1 F. R. Jackson, 79-4-T&P, 10 mi. N Ranger, TD 1,770 ft., pay 1,757 ft., flowed 100.48 bbl. of 41°-gravity oil a day.

Heinze & Sorrels 1 J. S. McKee, 39-7-T&P, 6 mi. E Moran, TD 3,800 ft., elev. 1,410 ft., pay 3,632 ft., flowed 25 bbl. of 44°-gravity oil a day, 12/64-in. choke, GOR 450 cu. ft., TP 180 psi.

Wise County: A. R. Dillard 1 B. F. McKay, Blk. 3, CSL, A-293, 1½ mi. NW Park Springs, TD 6,032 ft., elev. 996 ft., Caddo 5,602 ft., perf. conglomerate 5,733-49 ft., pumped 30 bbl. of 44°-gravity oil a day.

NORTH TEXAS (DISTRICTS 9 AND 7-B) WILDCAT FAILURES

Archer County: Akin & Dimock 1 Wilson Properties "A," Lot 4, Blk. 94, American Tribune New Colony Subd., 6½ mi. SE Mankins, dry, TD 5,032 ft., elev. 1,020 ft., Caddo 4,754 ft., Mississippian 4,955 ft., Ellenburger 4,970 ft.

W. F. Palmer 1 J. R. Parkey, Sec. 1, SPRR Sur., A-426, 5 mi. SW Holliday, dry, TD 1,800 ft.

Brown County: E. H. Stone 1 F. M. Crownover, Sec. 26, BBB&C Sur., 2 mi. S Rising Star, dry, TD 1,012 ft., sand with oil show 984 ft.

Coleman County: Westates Petroleum Corp. of Texas 1 L. J. Gray, Sec. 22, H. Warfield Sur., 4½ mi. W Novice, dry, TD 3,916 ft., elev. 1,977 ft., Gardner sand 3,742 ft., Gray sand 3,897 ft.

D. H. Wigner and Fred Bramlage 1 M. E. Abernathy, W. H. King Sur. 737, 3 mi. SE Coleman, dry, TD 2,380 ft., elev. 1,721 ft., top sand 2,368 ft.

Comanche County: Wells & Kelly Bros. 1 B. M. Paine, Sabina Draper Sur. A-237, 3 mi. NE Sidney, dry, TD 2,670 ft., elev. 1,365 ft., Caddo 1,806 ft., Marble Falls 2,373 ft., Mississippian 2,635 ft., Ellenburger 2,638 ft.

Clay County: Snuggs & Neal, Inc. 1 Parker CSL, Blk. 50, Parker CSL Sur., 4½ mi. SE Petrolia, dry, TD 1,806 ft. in shale.

Fisher County: S. B. Roberts 1 Fay Young Morton, Sec. 22, Austin & Williams Sur. 349, 5 mi. NW Hamlin, dry, TD 5,214 ft., elev. 1,770 ft., Flippen 3,118 ft., coal 3,110 ft., Swastika 3,707 ft., Canyon sand 4,458 ft., King 3,544 ft., Gunsight 3,648 ft.

Jones County: Clark & Cowden Drilling Corp. 1 J. C. Roberts, Sec. 38, Orphán Asylum Lands, 5 mi. E Anson, dry, TD 2,550 ft.

R. L. Wheelock, Jr. 1 Jess Young, Austin & Williams Sur., 1 mi. SE Hamlin, dry, TD 6,505 ft., elev. 1,711 ft., Valera 1,700 ft., Dotham 2,585 ft., Noodle 2,665 ft., Saddle Creek 2,890 ft., Flippen 2,954 ft.

Shackelford County: Exploration Drilling Co. 2 J. F. Dyer, 84-12-T&P, 12 mi. N Baird, dry, TD 937 ft.

Hooker - DeMohrenschildt, Ltd. 1 West, Sec. 18, BAL Sur., 2 mi. S Albany, dry, TD 917 ft.

Hooker - DeMohrenschildt, Ltd. 2 West, Sec. 18, BAL Sur., 2½ mi. S Albany, dry, TD 912 ft.

McElroy Ranch Co. 1 John H. Sedwick, Blk. 54, BAL Sur., 10 mi. E Albany, dry, TD 4,470 ft., elev. 1,319 ft., Caddo 3,656 ft., Ellenburger 4,426 ft.

Stonewall County: Seaboard Oil Co. 1 W. T. Martin, 4-U-T&P, 15 mi. NW Hamlin, dry, TD 6,514 ft., elev. 1,718 ft., Gunsight 3,784 ft., Swastika 3,834 ft., Canyon sand 3,862 ft.

Sun Oil Co. 1 Beulah Branch, SW SE 339-2-H&TC, 17 mi. SW Aspermont, dry, TD 6,955 ft., elev. 1,869 ft.

Throckmorton County: Harper & Turner 1 R. A. Mills, Sec. 3,093, TE&L Sur., 6 mi. N Throckmorton, dry, TD 5,160 ft.

Wilbarger County: Gray Oil Co. 1 W. T. Waggoner "B," 48-14-H&TC, 8 mi. SE Vernon, dry, TD 3,277 ft.

Frank Wood 1 W. T. Waggoner "Z," 3-13-H&TC, 4 mi. WSW Electra, dry, TD 2,505 ft.

Young County: Luke Grace Drilling Co. 1 E. H. Edmunds, Sec. 2909, TE&L Sur., A-1179, 2½ mi. NE Murray, dry, TD 3,688 ft.

W. M. Co. 1 S. R. Jeffrey, 56-X-TE&L, 3 mi. W Orth, dry, TD 975 ft., Gunsight lime 885 ft.

Wright, Senkel & Fleming et al 1-F M. K. Graham, Sec. 2400, TE&L Sur., A-1171, 5 mi. N Murray, dry, TD 4,677 ft., elev. 1179 ft.

Canadian Fields

Natural Gas Strike Continues Testing

CALGARY.—Superior Oil Co. of California, Ltd., has indicated a natural gas discovery at its Rio Bravo-Liebing 8-24, wildcat located about 11½ miles southeast of the town of Stettler. The well, in LSD 8, 24-38-18w4, some 17 miles northeast of Stettler Devonian oil production, drilled to 5,639 ft. and was plugged back to 4,208 ft. to test upper formations. A 136-minute test of the lower Cretaceous interval at 4,125-4,208 ft. gave a maximum natural gas flow rate of 2,675,000 cu. ft. daily. Testing is being continued.

Imperial Oil, Ltd. received some oil showings plus water in recent drill-stem tests in the D2 Devonian at its Stony Plain wildcat, and crew is now drilling in search of the D3 zone. The well, Imperial-Stony Plain 1, in LSD 8, 21-52-26w4, was chalked up as a natural gas strike in the lower Cretaceous, and found water in the D1 zone prior to proceeding for lower Devonian objectives. Recent D2 drill-stem tests run are as follows: at 4,777-89 ft., recovered 60 ft. of muddy gassy oil; at 4,789-99 ft., recovered 35 ft. of gas and oil-cut mud; at 4,779-4,809 ft., recovered 35 ft. of dead mud; at 4,807-44 ft., recovered 90 ft. of mud and 630 ft. of salty sulphur water. Gravity of the oil was measured at 35.5°. Drilling is now proceeding at 5,044 ft.

Oil encouragement has shown at an exploratory test in the Oyen area of southern Alberta, about 145 miles east-northeast of Calgary. The interesting wildcat, Oyen-Dannyboy 1, in LSD 3, 14-27-5w4, obtained some heavy crude oil in the Madison-Banff limestone formation during coring and drill-stem testing. Nac, Ltd., backers of the venture, reported that a 40-ft. core was pulled from the Banff bleeding heavy crude oil. Details of drill-stem testing have not been received, however, it is reported that during the latest test there was a recovery of 240 ft. of oil and gas-cut mud. Gravity of the oil is believed to be between 12° and 14°. There was no gas flow recorded. The venture will be carried

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down as a test of the Devonian, and drilling is now proceeding below 3,775 ft.

The Redwater Leaseholds Group has an assured success in the lower Cretaceous sands at its sixth well in the Campbell oil field, about 11 miles northwest of Edmonton. The new well, Redwater Leaseholds-Campbell 6, in LSD 12, 27-54-25w4, ran its first drill-stem test of the interval 3,673-93 ft. and received a natural gas flow to the surface in 5 minutes. Maximum gas flow rate was measured at 282,000 cu. ft. daily. When pipe was pulled recovery was 1,000 ft. of clean crude oil. Coring and testing is continuing.

Another 28 wells were completed in Alberta during the past week, boosting total number of completions for the year to 476. The week's results were 24 oil producers, 1 gas well, and 3 failures.

CANADIAN WILDCAT FAILURE

Bailey-North Stettler 1, LSD 16, 16-39-19w4, TD 5,451 ft.

Appalachian Field

Untested Area in W. Va. Gets Wildcat Location

PITTSBURGH.—An important wildcat test has been announced in Tolcott district, Summers County, West Virginia, at Godfrey L. Cabot, Inc. 1-1330 S. H. Pence, elevation 1,798 ft. It is on the Big Bend Quadrangle, 3.15 miles south of Lat. 37°. 45′, and 0.15 mile west of Long. 80°, 45′, on the waters of Hungard Creek. In Steele district, Wood County, Columbian Carbon Co. 1-GW-1154 H. C. McPherson et al, elevation 891 ft., Belleville Quadrangle, 0.64 mile south of Lat. 39°, .05′ and 2.70 miles west of Long. 81°, 30′, is drilling at 520 ft. In Portland district, Preston County, Hope Natural Gas Co. 9414 C. V. Ringer, elevation 2,194 ft., reported the Corniferous lime at 5,466 ft., chert at 5,487 ft., and is still drilling the chert. A good shallow sand gas well was completed in DeKalb district, Gilmer County: George W. Miller 1 C. S. Connolly, found 1,500,000 cu. ft. of gas in the Maxton sand, total depth 1,775 ft.

In Unity Township, Westmoreland County, Pennsylvania, Peoples Natural Gas Co. 1-3921 Fred Musnug, elevation 2,100 ft., is drilling at 3,568 ft. In Napier Township, Bedford County, South Penn et al, Snee & Eberly 1 Jesse B. Miller, elevation 1,666 ft., is drilling at 7,260 ft.

WEST VIRGINIA WILDCAT FAILURE

Randolph County, New Interest district: South Penn Oil Co. 1 J. W. Isner, dry, elev. 1,973 ft., Oriskany sand 1,730-1,864 ft., second Oriskany 3,045 ft., TD 6,097 ft.

Louisiana-Arkansas

Union County Prospect Reperforates Cotton Valley

SHREVEPORT.—Marine Oil Co. 1 Trigg, Union County test, in 33-17s-12w, reperforated at 4,422-32 ft. with 40 shots, and on a 2-hour test flowed a small amount of oil and gas through ¼-in. choke. The amount of oil was not reported. Operators were installing a pumping unit. Total depth was 6,158 ft. In the Smackover, plugged back to the Cotton Valley at 4,500 ft.

T. L. James & Co., Inc. 1 Clark Heirs, new shallow wildcat in 30-19s-12w, Union County, 10 miles south of Urbana field, had total depth at 2,339 ft. in the Nacatoch topped at 2,317 ft., by samples. A core from 2,319-31 ft. recovered 10 ft. of slightly porous sand with shows of oil, and from 2,331-39 ft. recovery was 2 ft. of sand with oil shows, plus 8 ft. of shaly sand. Tests had not been started at last report.

In Miller County, McAlester Fuel Co. 1-A Tullos, 22-16s-26w, was drilling in sand (lower Cretaceous) at 3,492 ft. A core from 3,238-44 ft. recovered 4½ ft. of shaly sand with oil show and 1½ ft. of shale with sand streaks. A 30-minute drill-stem test at 3,240-44 ft. recovered 5 ft. of mud with no shows. Cores from 3,244-64 ft. recovered shale and sandy shale with no shows. Two drill-stem tests of the lower section had failed..

Two miles west of Elm Grove field in Caddo Parish, J. D. Collins 1 W. A. Caplis, new 5,500-ft. wildcat, was conditioning mud at 2,855 ft. in the Paluxy after blowing out at that depth, making an estimated 500,000 cu. ft. of gas daily. Location is in 33-16n-12w, on a subsurface prospect.

Atlantic Refining Co. 1-F Louisiana Central, 17-12n-4e, Caldwell Parish, was drilling at 7,450 ft. in the lower Cretaceous, following 39 side-wall cores from 1,875-7,294 ft.

Continental Oil Co. 1 Wideman, 21-21n-7w, Claiborne Parish, was coring at 6,466 ft. in sand, following 17 side-wall cores from 3,449-5,873 ft. A show of oil was reported at 5,873 ft., which was about 68 ft. into the Cotton Valley formation.

Stanolind 1 Meadors, deep wildcat in 8-22n-5w, Claiborne Parish, was coring in sand at 9,117 ft. Recovery from 9,065-75 ft. was siltstone and conglomerate with a very light show of oil, and from 9,075-9,115 ft. recovery was sandstone and conglomerate with light oil show.

NORTH LOUISIANA WILDCAT FAILURE

Morehouse Parish: C. N. Valerius 1 Crossett, NE NE 21-23n-7e, dry, TD 5,600 ft., elev. 155 ft., Wilcox 1,555 ft., Midway 2,267 ft., Cotton Valley 2,955 ft., Smackover 5,434 ft., porosity 5,462 ft.

ARKANSAS WILDCAT FAILURE

Union County: Pioneer Drilling Co. 3 Baker, NW SE SE 22-16s-14w, dry, TD 2,546 ft., elev. 166 ft., Meakin sand 2,539 ft.

Ohio Fields

Clinton Sand Well Fills Up, Will Swab Into Production

COLUMBUS.—Foraker Drilling 5 F. C. Henderson, Section 18, Hopewell Township, Perry County, with the Clinton sand at 2,812-25 ft., filled up 1,300 ft. with oil in 24 hours, natural. After shot, the well flowed 60 bbl. and then loaded up to where it would not flow and will have to be swabbed.

Mid East Oil Co. finished a fishing job on the 1 Asbury Cannon, Section 11, Clayton Township, Perry County, and shot the well with 100 qt. The Clinton was logged at 3,450-80 ft. with a good showing, natural, and made 43 bbl. in 24 hours after the shot.

National Gas Co. deepened its 1 Everett Coffey, Section 15, Salt Creek Township, Muskingum County, from 29 ft. in the Clinton sand to 4,200 ft. through the Medina. An oil pay was found in the bottom of the Clinton and another in the Medina at 4,178-85 ft. Both pays were shot and the well made 70 bbl. in 24 hours.

E. O. White and R. E. Yocom have started a wildcat on William Koppert, Lot 6, 3rd Quarter, Cass Township, Muskingum County. The test is 3 miles southeast of present activity in Jackson Township.

Illinois-Ind.-Ky.

Gallatin County Wildcat Shows for Cypress Well

ARNOLD VALTER has encountered good oil showings in his 1 Drone, NE NE NE 27-8s-9e, a wildcat in the area 3 miles east of Ridgway, Gallatin County, Illinois. Indications are that another new pool has been uncovered. Showings were in Cypress sand at a total depth of 2,486 ft. Following a 60-minute drill-stem test of the zone, the well had more than 375 ft. of clean oil in the pipe. Casing has been run for production tests, and cable tools are being moved in to drill out plug. Nearest production is in the Inman pool, more than 1 mile to the northeast.

Another discovery for the Owensville area in Gibson County, Indiana, also appears to have been made by Ashland Oil & Refining Co. and associates at their 1 Mounts, SE SW 19-3s-11w. The well found oil saturation in a sandy lime zone of the Aux Vases at 2,482-89 ft. A drill-stem test had a good show of gas and yielded 185 ft. of clean oil and 35 ft. of oil-cut mud. Tester was open 60 minutes. There was no indication of water. Casing has been run for completion. The location is about 2½ miles south of the Owensville townsite and about ¾ mile from production in the East Owensville pool.

Stewart Oil Co. 1 Johnson, NW SW NW 28-6s-5e, which opens a new producing area about a mile north of the Cantrell pool and about the same distance south of the Rural Hill pool, in southwestern Hamilton County, swabbed at the rate of 161 bbl. of oil per day while testing its Aux Vases pay zone at 3,240-53 ft. This is the second oil-find by this company in the general area within the past 2 weeks. Previously, the company's 1 James, NW SE NE 11-6s-5e, 3½ miles northeast of the Johnson well, on the north side of the Rural Hill pool, had been completed flowing initially more than 600 bbl. daily from the Aux Vases zone at 3,194-3,214 ft.

George & Wrather have completed their 1 West, NE NE SW 34-3n-14w, 4 miles east of Calhoun, Richland County, flowing at the rate of 359 bbl. of oil daily, opening a new producing area about ¾ mile from nearest wells in the Bonpas pool. Production is from Rosiclare at 3,070-82 ft. Two additional tests are being drilled in the immediate vicinity.

Skiles Oil Corp. 1 Watkins Heirs, SE NE NW 11-3n-9e, on the east side of the Clay City-Noble Consolidated pool in the sector about 4 miles west of Olney, Richland County, Illinois, is preparing to test what is reported to have been excellent oil showings in Rosiclare lime. The well was drilled as a "tight" hole, and no authoritative information is available, but observers state that the well flowed clean oil in a drill-stem test. Total depth is given as 2,964 ft. If a well is made in the Rosiclare, it will be the first production from that zone in the area.

Opening of a new pay zone, the O'Hara lime, for the Oatesville area, 4 miles northwest of Oakland City, Pike County, Indiana, is indicated by results of a drill-stem test made by Warren Usrey and John Organ in their 1 Belcher, W½ SE NE 27-1s-9w. The O'Hara saturation was logged at 1,526-44 ft. The test, lasting 45 minutes, showed gas within 1 minute after the tool was opened. At the conclusion, there was 120 ft. of clean oil with 100 ft. of drilling mud in the pipe.

ILLINOIS WILDCAT FAILURES

Adams County: Walter Vitte 1 Haschemeyer, SW SE SE 23-2n-6w 4th P.M., dry, TD 668 ft.

Clark County: Ward W. Dayton 1 Pine, SW NE SE 25-11n-11w, dry, TD 2,241 ft.

Clinton County: T. M. Conrey 1 Kneier, NW NW NE 13-3n-3w, dry, TD 1,141 ft.

Edgar County: E. T. Spicer 1 Thiel, NE NE NE 6-13n-13w, dry, TD 455 ft.

Gallatin County: Calvert Drilling Co. 1 Kanady, NE NE NE 24-8s-8e, dry, TD 2,840 ft.

Hamilton County: C. E. Brehm 1 Mitchell, NE SW NW 2-6s-7e, dry, TD 3,394 ft. Hoesmeyer et al., 1 Rountree, SE SW SW 24-6s-6e, dry, TD 3,140 ft.

Jasper County: J. W. Rudy 1 Kingery, SE SW SE 25-6n-8e, dry, TD 3,165 ft. Skiles Oil Corp. 1 Jones, SE SE SW 27-7n-8e, dry, TD 3,110 ft.

Jefferson County: Joe Reznik and R. Halbert 1 Morgan, SE SW NW 24-3s-2e, dry, TD 2,860 ft.

(Continued on page 389)

June Completions and Footage Set New Record for Year

by Polly DeArmond

JUNE was a month of records for 1950: completions topped all previous marks, footage climbed to a new peak, and the rigs-and-drilling figure was the highest since November 1948. The number of wells reached 4,079, accounting for 14,950,604 ft. total footage. These figures represent increases of 15.6 per cent in completions and 18.3 per cent in footage over the preceding month, and gains of 9.9 per cent and 11.4 per cent, respectively, over June 1949.

June Vs. May 1950

Every area but one reported increases in both completion and footage categories in the June vs. May analysis. The exception was California, which was up 12 wells, or 8.6 per cent, but down 30,105 ft., or 4.6 per cent.

Southwestern United States and Rocky Mountain regions accounted for most of the increases. The Texas-New Mexico area noted gains of 434 completions, or 34.2 per cent, and 2,039,064 ft., or 37.5 per cent, while Montana, Wyoming, Colorado, Utah, and the Dakotas increased 22 wells, or 34.9 per cent, and 88,038 ft., or 36 per cent.

The southern group, made up of Louisiana, Arkansas, Mississippi, Alabama, Georgia, and Florida, was up 32 completions, or 12 per cent, but increased only 11,208 ft., due to the fact that most of the increase in activity occurred in the shallower parts of North Louisiana and Arkansas.

The eastern states of New York, Pennsylvania, and West Virginia continued their recent upsurge in operations, showing a 25-well gain in completions, or 10 per cent, and a 50,456-ft. increase in footage, or 10.8 per cent, over the preceding month.

Ohio, Kentucky, Illinois, Indiana, and Michigan were up 12 completions, or 1.7 per cent, and 53,745 ft., or 3.9 per cent. Kansas, Nebraska, and Oklahoma increased 14 wells, or 1.6 per cent, and 102,580 ft., or 3.6 per cent.

June 1950 Vs. June 1949

The Mid-Continent increased 26.8 per cent in wells and 33.9 per cent in footage over June of the previous year. Texas et al gained 12.7 per cent in completions and 17.5 per cent in footage. The north-central area was up 12.9 per cent in wells and 4 per cent in footage, while the eastern fields increased 4.9 per cent in wells and 5.7 per cent in footage.

The Rocky Mountain region was down 1 per cent in completions but up 17.8 per cent in footage, and the southern division had hardly any change in wells but gained 2.2 per cent in footage. Both completions and footage fell off in California from the corresponding month of 1949.

SUMMARY OF COMPLETIONS—JUNE 1950

	Total comp.	Oil	Gas	Dry	Under 2,500 ft.	2,500-5,000 ft.	5,000-7,500 ft.	7,500-10,000 ft.	10,000-12,500 ft.	Over 12,500 ft.	Total footage	Rigs and drilling
New York	65	33	0	32	65	0	0	0	0	0	93,000	§47
Pennsylvania	148	67	28	53	122	26	0	0	0	0	263,194	211
West Virginia	62	18	35	9	39	18	5	0	0	0	160,714	¶152
Ohio	92	29	28	35	53	39	0	0	0	0	188,551	138
Kentucky	111	53	15	43	92	19	0	0	0	0	196,231	88
Illinois	272	131	2	139	136	136	0	0	0	0	617,351	318
Indiana	158	65	1	92	128	30	0	0	0	0	268,689	192
Michigan	67	26	1	40	48	19	0	0	0	0	136,421	178
Kansas	343	172	44	127	33	307	3	0	0	0	1,115,069	388
Neb., Mo., Iowa	22	4	2	16	7	14	1	0	0	0	69,848	24
Oklahoma	501	310	28	163	135	260	82	6	17	1	1,794,271	847
Texas	1,647	1,053	68	526	425	595	458	138	28	3	7,249,600	1,629
North	301	153	5	143	158	107	36	0	0	0	862,107	155
West Central	174	77	5	92	80	80	14	0	0	0	495,443	179
West	458	382	1	75	64	110	239	32	10	3	2,513,579	720
Panhandle	78	48	23	7	3	71	0	3	1	0	261,887	119
East	168	127	3	38	36	96	24	12	0	0	654,261	89
Gulf Coast	247	153	16	78	15	66	90	65	11	0	1,487,775	222
Southwest	221	113	15	93	69	65	55	26	6	0	974,548	145
Louisiana	216	146	14	56	79	32	27	29	45	4	1,225,689	245
Northern	119	79	13	27	79	20	16	3	1	0	347,318	85
Southern	97	67	1	29	0	12	11	26	44	4	878,371	160
Arkansas	43	26	0	17	13	27	2	1	0	0	127,366	45
Mississippi	34	16	1	17	0	2	22	6	4	0	235,827	24
Ala., Ga., Fla.	6	2	0	4	0	4	0	1	1	0	33,673	9
Montana	21	12	0	9	11	10	0	0	0	0	31,743	66
Wyoming	57	36	2	19	5	33	12	6	1	0	275,612	‖131
Colorado	2	0	1	1	0	1	1	0	0	0	9,800	32
Utah	3	2	0	1	0	3	0	0	0	0	12,519	17
New Mexico	55	40	5	10	11	31	6	5	2	0	219,224	**140
California	152	108	3	41	48	60	23	13	5	3	623,577	194
Dakotas	2	0	0	2	2	0	0	0	0	0	2,635	3
Total June 1950	4,079	†2,349	278	*1,452	1,452	1,666	642	205	103	11	14,950,604	‡5,118
Total May 1950††	3,528	1,994	255	1,279	1,345	1,407	496	187	84	9	12,635,618	4,874
Total June 1949	3,712	2,133	240	1,339	1,386	1,538	481	203	92	12	13,418,510	4,553
Cumulative 1950	20,258	11,707	1,341	7,210	7,353	8,072	3,231	1,056	482	64	74,816,448	....
Cumulative 1949	18,794	10,725	1,312	6,757	6,855	7,835	2,472	1,089	477	66	68,228,249	....
Western Canada	95	73	7	15	2	75	16	2	0	0	349,616	85
Cumulative 1950	405	304	15	86	8	286	104	7	0	0	1,597,363	....

*Incl. 119 service wells: N. Y. 32, Pa. 49, Ohio 5, Ind. 1, Mich. 10, Kans. 3, Okla. 8, No. Tex. 1, W. Cent. Tex. 1, E. Tex. 7, Tex. Gulf 1, S.W. Tex. 1. †Incl. 41 distillate wells: Okla. 1, W. Tex. 6, E. Tex. 5, Tex. Gulf 6, S.W. Tex. 1, No. La. 3, So. La. 11, Miss. 6, Calif. 2. ‡Incl. all wells rigged up and/or drilling at end of month. §Incl. 2 Md. ¶Incl. 2 Va. ‖Incl. 3 Idaho. **Incl. 5 Ariz. ††Revised.

XUM

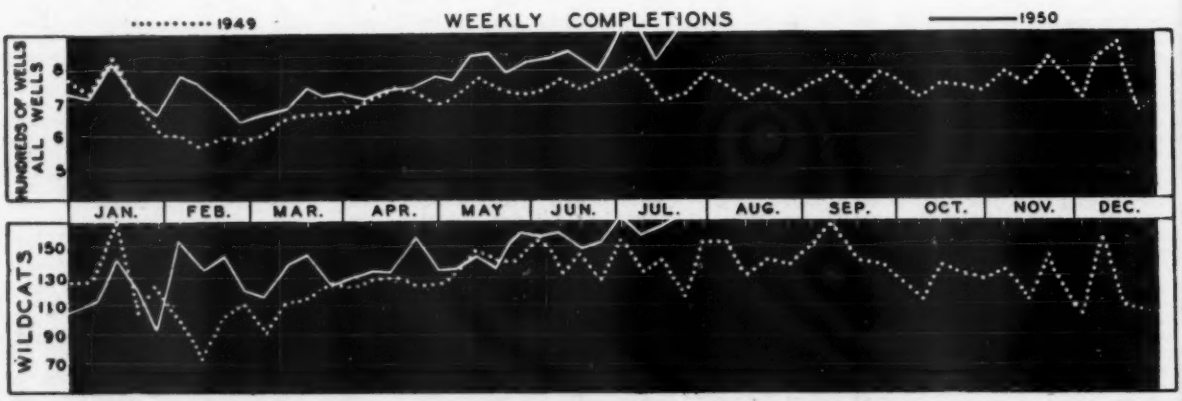
CURRENT STATISTICS

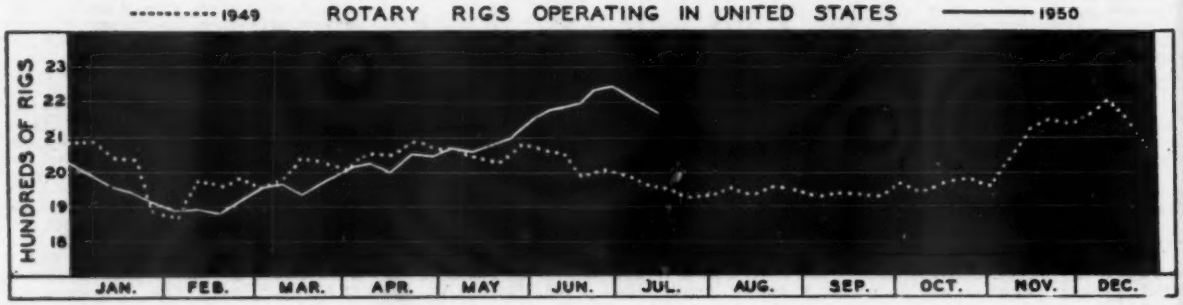
EXPLORATION

WEEKLY WELL COMPLETIONS . . . . WEEK ENDED JULY 22, 1950

	Total of all wells					July 22		Wildcat completions and discoveries					Cumulative total, 1950				
	Comp.	Oil	Gas	Dry	Footage	1950	1949	Oil	Dist.	Gas	Dry	Total	Oil	Dist.	Gas	Dry	Total
New York	13	7	0	*6	14,832	360	636	0	0	0	0	0	0	0	0	0	0
Pennsylvania	19	6	5	†8	34,089	766	1,001	0	0	0	0	0	0	0	1	2	3
West Virginia	17	3	13	1	48,892	363	272	0	0	0	1	1	0	0	11	13	24
Ohio	21	8	3	‡10	38,291	536	609	0	0	0	0	0	1	0	1	7	9
Indiana	36	15	0	21	54,415	853	713	4	0	0	3	7	26	0	1	151	178
Kentucky	14	4	3	7	26,618	576	494	1	0	0	1	2	14	0	1	44	59
Illinois	73	28	0	45	171,691	1,388	1,316	0	0	0	18	18	28	0	1	329	358
Michigan	20	6	1	13	42,604	452	528	0	0	0	8	8	18	0	4	148	170
Kansas	80	31	12	37	256,484	2,062	1,756	2	0	1	16	19	51	0	5	325	381
Nebraska	2	0	0	2	9,343	53	17	0	0	0	2	2	2	0	1	25	28
Oklahoma	105	64	3	§38	369,907	2,969	2,363	4	0	0	12	16	92	5	11	363	471
Texas	382	249	15	118	1,682,907	8,982	7,608	13	1	0	62	76	272	22	65	1,402	1,761
N. Central (Dist. 7-B & 9)	116	61	1	54	310,902	2,737	2,463	6	0	0	23	29	117	2	17	534	670
West (Dist. 7-C & 8)	125	107	0	§18	656,395	2,639	1,800	2	0	0	7	9	55	2	2	264	323
Panhandle (Dist. 10)	16	7	7	2	49,806	531	599	0	0	0	0	0	1	0	2	11	14
Eastern (Dist. 5, 6, & 6-P)	19	13	0	6	67,145	654	481	0	0	0	5	5	8	3	1	117	129
Gulf Coast (Dist. 2 & 3)	57	33	4	20	367,546	1,258	1,118	2	1	0	13	16	44	8	24	199	275
Southwest (Dist. 1 & 4)	49	28	3	18	231,113	1,163	1,147	3	0	0	14	17	47	7	19	277	350
Louisiana	49	29	2	18	285,130	1,334	1,192	0	0	0	6	6	29	12	4	107	152
Northern	23	13	1	§9	61,788	697	649	0	0	0	1	1	4	2	1	46	53
Southern	26	16	1	9	223,342	637	543	0	0	0	5	5	25	10	3	61	99
Arkansas	11	5	1	§5	38,663	223	176	0	0	0	1	1	5	0	0	52	57
Mississippi	3	0	0	3	22,028	181	199	0	0	0	3	3	8	2	0	64	74
Southeastern States	2	0	0	2	10,417	36	26	0	0	0	2	2	1	0	1	22	24
Montana	2	0	0	2	4,384	104	131	0	0	0	0	0	1	0	0	14	15
Wyoming	7	4	0	3	29,391	302	329	1	0	0	1	2	10	0	0	38	48
Colorado-Utah	4	0	0	4	14,299	37	64	0	0	0	4	4	2	0	0	28	30
New Mexico	11	7	2	2	39,822	341	305	0	0	0	1	1	10	1	0	30	41
California	46	32	1	13	158,541	952	1,498	0	0	0	10	10	14	0	2	203	219
Miscellaneous	0	0	0	0	0	34	15	0	0	0	0	0	0	0	0	9	9
Total United States	917	498	61	358	3,352,748	‖22,904	21,248	25	1	1	151	178	584	42	109	3,376	4,111
Total previous week	821	446	65	310	2,849,480	.....	.....	23	4	2	136	165	559	41	108	3,225	3,933
Total July 22, 1949	729	413	55	261	2,483,443	.....	.....	16	2	5	91	114	512	51	105	3,022	3,690

Service wells included: *6, †8, ‡2, §1. ‖Revised.





DAILY AVERAGE PRODUCTION FOR WEEK

	July 22 crude oil	B. of M. July demand	July 15 crude oil
Alabama	1,750	1,600	1,500
Arkansas	81,000	89,000	79,850
California	886,400	860,000	883,500
Colorado	59,400	68,000	59,200
Eastern	63,000	63,000	62,500
Florida	1,400	1,400	1,500
Illinois	172,700	186,000	172,400
Indiana	31,100	30,000	30,000
Kansas	322,600	290,000	277,600
Kentucky	28,300	28,000	28,400
Louisiana	560,700	565,000	563,600
North Louisiana	115,400	.....	118,300
South Louisiana	445,300	.....	445,300
Michigan	42,500	47,000	39,600
Mississippi	113,750	110,000	111,300
Montana	22,200	25,000	22,100
Nebraska	2,450	3,000	2,450
New Mexico	132,575	148,000	132,575
Oklahoma	442,100	445,000	443,450
Texas	2,329,900	2,190,000	2,329,900
Dist. 1 (Southwest)	29,450	.....	29,450
Dist. 2 (Southwest)	138,875	.....	138,875
Dist. 4 (Southwest)	218,000	.....	218,000
Dist. 3 (Gulf Coast)	390,150	.....	390,150
Dist. 5 (Eastern)	36,200	.....	36,200
Dist. 6 (Eastern)	93,600	.....	93,600
East Texas field	275,400	.....	275,400
Dist. 7-C (West)	57,725	.....	57,725
Dist. 8 (West)	772,775	.....	772,775
Dist. 7-B (W. Central)	72,100	.....	72,100
Dist. 9 (N. Central)	153,100	.....	153,100
Dist. 10 (Panhandle)	92,525	.....	92,525
Utah	3,600	4,000	3,600
Wyoming	158,300	156,000	158,400
Total United States	*5,455,725	5,310,000	5,403,425
Change from previous week, up	52,300		
Canada	83,435	.....	81,000

Total U. S. production January 1-July 22 ..... †1,037,351,490 bbl.
Same period last year (crude plus cond.) ..... 1,042,951,615 bbl.

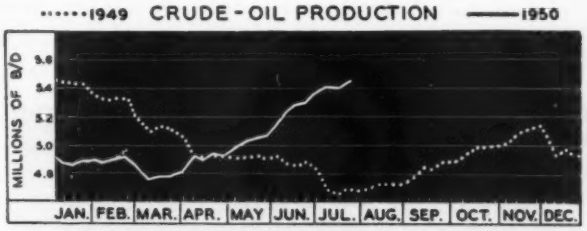
*Not including 98,425 bbl. condensate. †Including 19,785,640 bbl. condensate.

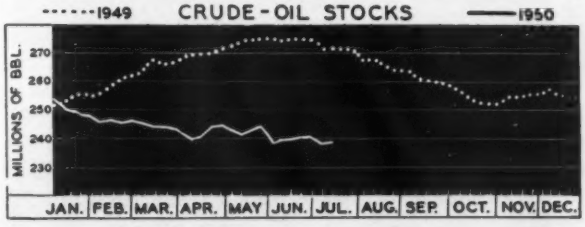
CRUDE-OIL STOCKS BY STATES OF ORIGIN*

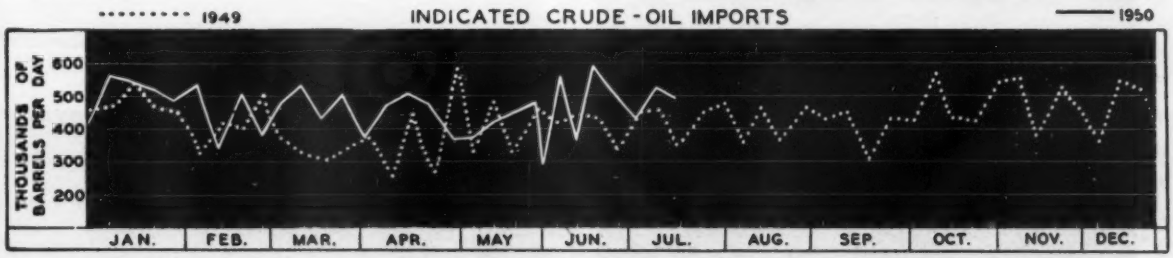
(Thousands of barrels)

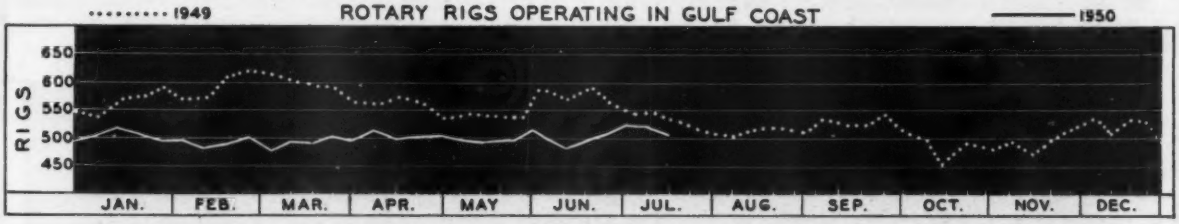
	July 15, 1950	July 8, 1950	July 16, 1949
Pennsylvania Grade	2,754	2,754	3,032
Other Applachian	1,579	1,580	2,121
Illinois, Indiana, Michigan	9,071	8,838	14,913
Arkansas	2,808	2,983	3,008
Louisiana	15,202	14,107	15,460
North	3,118	3,269	3,611
Gulf	12,084	10,838	11,849
Mississippi	2,394	2,114	3,157
New Mexico	6,188	5,801	7,703
Oklahoma and Kansas	33,126	33,813	39,209
Texas	112,098	111,736	127,060
East Texas	15,682	15,372	16,844
West Texas	41,250	41,522	51,529
Texas Gulf	27,693	26,856	29,861
Other Texas	27,473	27,986	28,826
Rocky Mountain	12,220	12,366	14,126
California	34,536	34,683	35,204
Foreign	6,509	6,496	7,155
Total	238,485	237,271	272,148

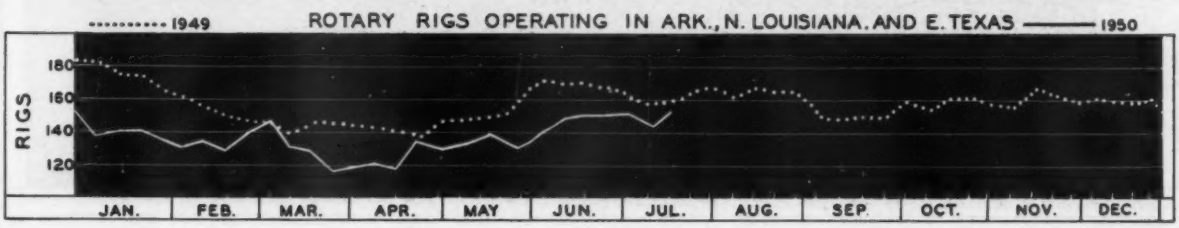
*Bureau of Mines.









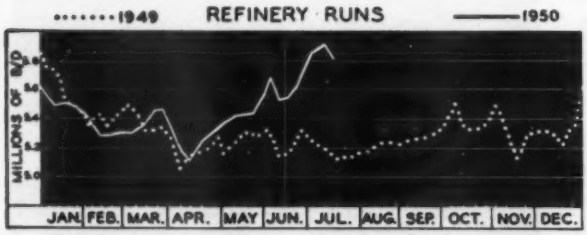

1949 ROTARY RIGS OPERATING IN ARK., N. LOUISIANA, AND E. TEXAS 1950
RIGS
180
160
140
120
JAN. FEB. MAR. APR. MAY JUN. JUL. AUG. SEP. OCT. NOV. DEC.

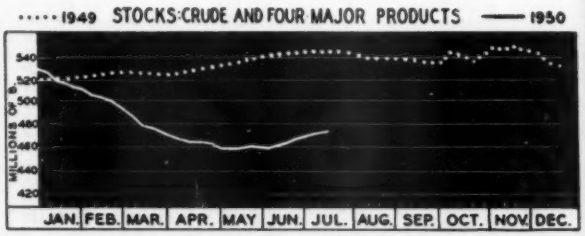
A.P.I. REFINERY REPORT, JULY 15

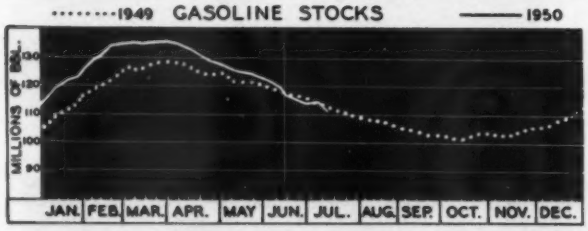
(Thousands of barrels)

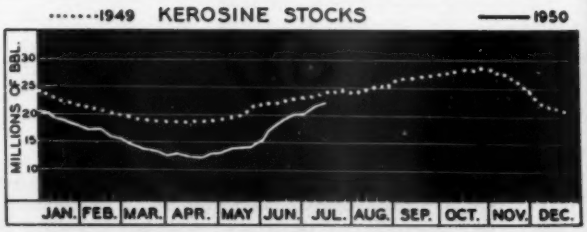
District—	Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual	Stocks at refineries, bulk terminals, in transit and in pipe lines: Gasoline†	Kerosine	Distillate	Residual	Bureau of Mines, July 1949: Daily avg. crude runs	Daily average production: Gasoline*	Kerosine	Distillate	Residual
East Coast	975	379.7	36.8	184.2	208.1	25,983	7,777	14,953	10,577	745	319.2	23.3	155.4	161.7
Appalachian:														
District 1	109	42.7	5.3	12.4	9.9	2,426	419	651	389	87	40.7	2.7	11.4	8.9
District 2	68	34.3	3.9	5.1	12.3	879	144	196	238	64	35.4	1.3	6.0	12.0
Ind., Ill., Ky.	1,061	560.6	58.6	166.7	142.0	22,386	4,307	9,430	3,971	895	492.3	42.9	122.0	117.1
Okla., Kans., Mo.	513	280.9	12.7	107.0	61.0	11,067	1,258	5,447	1,307	427	238.0	17.9	82.3	57.6
Inland Texas	213	138.6	12.3	27.4	39.7	3,293	494	1,062	749	227	156.4	12.3	18.2	49.3
Texas Gulf Coast	1,237	622.3	92.0	246.7	226.7	16,535	3,701	9,405	4,923	1,217	623.0	66.2	176.7	225.9
La. Gulf Coast	477	221.7	54.6	104.1	53.9	5,594	2,690	3,182	1,922	404	212.4	38.0	88.0	45.3
N. La. and Ark.	70	25.1	7.4	13.7	11.4	2,696	410	543	252	73	31.3	5.1	11.2	14.9
Rocky Mountain:														
New Mexico	13	7.1	.4	1.7	2.7	103	25	69	34	12	6.7	0.2	2.3	3.2
Other Rocky Mtn.	180	85.0	5.1	35.4	36.6	4,374	414	1,521	754	175	76.8	4.5	29.8	33.5
California	890	360.7	17.6	121.2	342.3	16,403	893	12,199	17,592	847	381.0	10.6	131.2	310.9
July 15, 1950	5,806	2,758.7	306.7	1,025.6	1,146.6	111,739	22,532	58,658	42,708	5,173	2,613.2	225.0	834.5	1,040.3
July 8, 1950	5,912	2,865.6	250.3	1,050.4	1,130.9	114,278	22,035	56,568	41,874	.....	.....	.....	.....	.....
July 16, 1949	5,130	2,588.1	218.7	814.1	1,112.1	111,464	23,791	68,622	67,799	.....	.....	.....	.....	.....

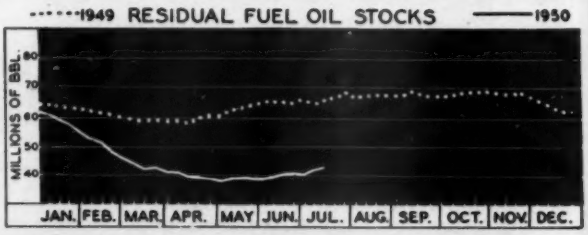
*At refineries including natural blended. †Finished and unfinished.

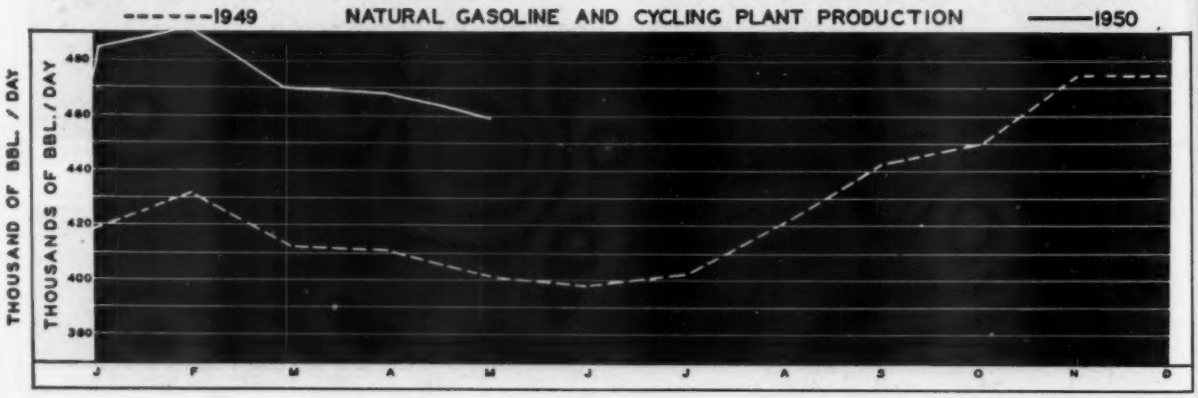












CRUDE PRICES

GRAVITY SCHEDULE

Gravity—	Signal Hill, Calif.	Oklahoma, Kansas	Gulf Coast Tex.*	West Tex.†
18-18.9	$1.63	....	....	....
19-19.9	1.72	....	....	....
20-20.9	1.80	$2.25	....	$2.12
21-21.9	1.89	2.27	....	2.14
22-22.9	1.97	2.29	....	2.16
23-23.9	20.6	2.31	....	2.18
24-24.9	2.14	2.33	$2.56	2.20
25-25.9	2.23	2.35	2.58	2.22
26-26.9	2.31	2.37	2.60	2.24
27-27.9	2.37	2.39	2.62	2.26
28-28.9	2.42	2.41	2.64	2.28
29-29.9	2.48	2.43	2.66	2.30
30-30.9	2.54	2.45	2.68	2.32
31-31.9	2.59	2.47	2.70	2.34
32-32.9	2.64	2.49	2.72	2.36
33-33.9	....	2.51	2.74	2.38
34-34.9	....	2.53	2.76	2.40
35-35.9	....	2.55	2.78	2.42
36-36.9	....	2.57	2.80	2.44
37-37.9	....	2.59	2.82	2.46
38-38.9	....	2.61	2.84	2.48
39-39.9	....	2.63	2.86	2.50
40 and above	....	2.65	2.88	2.52

*For crude from Daboval, El Campo, and Sand Point.

†Includes Lea County, New Mexico. Last general price change represented a 50-cent increase becoming effective December 6, 1947.

FLAT CRUDE PRICES

Representative posted schedules per barrel.

East Texas†	$2.65
Kettleman Hills, California*	2.77
Beauregard Parish	2.60
Illinois Basin	2.77
Pecos County, Texas (Yates)	2.35
Bradford, Pennsylvania	3.89
Eastern Ill. and Western Ind.†	2.77
Tomball, Texas Gulf Coast	2.83

*37°-37.9°. †35° and above.

PETROLEUM marketing for the week was highlighted by a general strengthening of gasoline prices in all areas.

The increase of .25 cent a gallon for barge deliveries in New York Harbor was stabilized at the generally quoted price of 12.5 cents for unbranded regular. Increases at the tank-wagon level spread all down the Atlantic Coast.

Tank-wagon prices in Texas reflected the firmer refinery market with an increase of .5 cent a gallon.

Group 3 tank-car prices for gasoline were up .125 cent a gallon. This increase had been expected for some time, and suppliers were of the opinion that part of the delay was due to high refinery runs in the first half of the month. Some were waiting to see if gasoline demand would be great enough to reduce stocks despite the high level of production. The stock trend was stabilized by a reduction of 2,500,000 bbl. for the week ended July 15.

Grade 26-70 natural gasoline moved up .125 cent a gallon to 5.75 cents for Group 3 and 5.25 cents for North Texas. This is still .125 cent less than postings at the first of the year.

Discounts of .4 cent a gallon off the New York Harbor postings for No. 2 fuel, covering deliveries to New Jersey, have been discontinued, with the market tight at 8 cents. This price provides little margin for handling costs since spot material on the gulf is hard to find at less than 7.25 cents and tanker rates are about .7 cent.

Residual fuel on the Group 3 market regained the 5 cents lost in June, bringing the low to $1.65 a barrel.

Increased demands for lubricating oils have resulted in firmer lube markets for several months. This, in turn, has brought four increases in Pennsylvania Grade crude prices, starting last December.

REPRESENTATIVE QUOTATIONS

Representative spot-market quotation of leading suppliers as of July 24, 1950. Figures are f.o.b. plant for tank-car shipments in cents per gallon, except for residual fuel oil which shows the price per barrel and wax, in cents per pound.

GASOLINE, KEROSINE, AND FUEL OILS

	Mid-Continent Group 3	New York Harbor (barge)	Texas Gulf Coast
Regular gasoline, 80-82 octane	10¼-10½	12.5	10⅞-11½
Premium gasoline, 86-88 octane	11-11½	13.5	11½-12½
42-44 w.w. kerosine	8¾-8½	9.1	8-8½
No. 2 straw fuel oil	7½-7⅝	8.0	7-7¼
No. 6 residual	$1.65-1.70	$2.15	$1.75-1.85

NATURAL GASOLINE

	Group 3	North Texas	N. La.
Grade 26-70	5¾	5¼	5½
Grade 18-55	6.9	6.4	6.65

LUBRICATING OILS

South Texas

200 vis., No. 2-3 neutral	11.5
750 vis., No. 3-4 neutral	13.75
2,000 No. 5-6 neutral	15.5

LUBRICATING OILS

Mid-Continent

150-160 vis., D bright stock, 0-10 pp.	20
200 vis., No. 3 neutral, 0-10 pp.	13.5

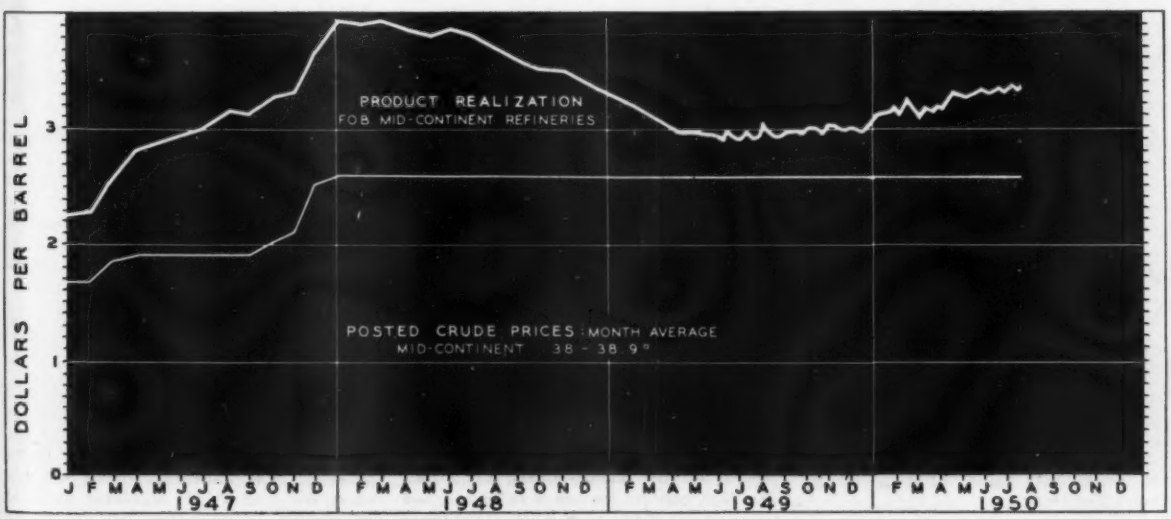
Western Pennsylvania

145-155 vis., 10 p.t. bright stock	23.5
180 vis., 0 p.t. neutral	24.5

WAX

Mid-Continent

132-134 A.M.P.	4.50


DOLLARS PER BARREL
3
2
1
0
PRODUCT REALIZATION
F.O.B. MID-CONTINENT REFINERIES
POSTED CRUDE PRICES 1 MONTH AVERAGE
MID-CONTINENT 38 - 38.9°
J F M A M J J A S O N D
1947
F M A M J J A S O N D
1948
F M A M J J A S O N D
1949
F M A M J J A S O N D
1950

In this trend chart refinery realization is based on average Mid-Continent grade crude oil (not 38° gravity only) and average prices for refinery products as published in The Oil and Gas Journal basis Oklahoma (Group 3). Refinery yields confined to gasoline, kerosine, distillate, and fuel oil. Realization averaged $3.34 for week ended July 15, $3.31 for previous week, and $2.97 for July 1949.

XUM

EQUIPMENT MEN . . . in the News

Jones Is Named Sales Manager of United Supply

Neil Jones has been appointed sales manager of United Supply & Manufacturing Co., Tulsa, according to

NEIL JONES

T. J. HOLLADAY

H. B. Gutelius, president. Gutelius also announced the appointment of Thurman J. Holladay to manage United's new store at Snyder, Tex.

Jones has been associated in sales work for United Supply since 1941, in Odessa and Tulsa. He attended Oklahoma A. & M. College, and University of Oklahoma, and graduated from University of Alabama.

Holladay was transferred from United's Hobbs, N. M., store to his new assignment. Other United stores opened recently are at Ringwood and Elk City, Okla., and at Homer, La.

Pipe-Line Construction Is Subject of New Movie

All phases of pipe-line construction, including trenching, rock drilling, blasting, welding, doping, wrapping, laying and backfilling are pictured in a new construction film titled "As the Crow Flies," and now being distributed by Gardner - Denver Co., Quincy, Ill.

All scenes were photographed in the Cumberland Mountains, between Green Brier and Oak Ridge, Tenn. Action shows construction work on the 172-mile, 22-in. natural-gas line laid by Oman-Fulton-Brodie Co.

W. H. Cordes Named Staff Manager, Sales Department

Wilmer H. Cordes, manager of market development and advertising of American Steel & Wire Co., has been named general staff manager of the company's sales department, it has been announced by H. M. Francis, vice president, sales, of this U. S. Steel subsidiary.

In his new capacity, Cordes succeeds Paul L. Lindsay, recently appointed Cincinnati district manager of sales. He has been associated with American Steel & Wire since he started at the age of 16 as a messenger in the company's Chicago sales office.

In 1922 he was named assistant advertising manager. Six years later he became manager of the advertising department, and in 1935 the sales-promotion responsibility also was added to his assignment. Since February 1949, he has been manager of market development and advertising.

Carmichael Returns to Brewster as Chief Engineer

J. T. CARMICHAEL

James T. Carmichael has recently returned to Brewster Co., Shreveport, as chief engineer, after heing with Penrod Drilling Co. for the past 18 months.

Carmichael was formerly with Brewster for 10 years, serving as chief engineer the last 3 years of that period. While with Penrod, he engineered the world's largest drilling barge.

He graduated from Georgia Institute of Technology in 1936 in mechanical engineering and was on the engineering staff of Beaird Co., Shreveport, prior to his connection with Brewster.

British Firm Supplies Trucks to Iraq Petroleum

Iraq Petroleum Co., Ltd., has ordered a group of these English-made trucks for use in the transport and stringing of pipe on the company's 556-mile Kirkuk-Banias, Syria line. The 30-in. pipe for the line is being obtained in the United States, and much of the other equipment in nondollar areas. These trucks provide a gross laden running weight of up to 100 long tons.

Patterson, Shadrach Named By Fairbanks, Morse & Co.

The oil-field department of Fairbanks, Morse & Co. at Dallas has announced the appointment of two new field engineers to represent its firm in Wichita Falls and Corpus Christi territories.

Wayne F. Patterson became associated with Fairbanks, Morse in the oil-field department in Dallas in June 1947, after studying engineering at Southern Methodist University upon his discharge from the service. Patterson will serve the Wichita Falls territory.

William S. Shadrach, Jr., joined Fairbanks, Morse in the oil-field department at the Dallas branch in August 1948, after attending Southern Methodist University. He will serve the Corpus Christi territory.

J. A. Green Forms Sales And Service Firms

John A. Green has established John A. Green Co., manufacturer's representatives, and Equipment & Service Co., consulting engineers and electrical manufacturers, at Dallas.

J. A. GREEN

For 9 years Green had been an electrical engineer with Collins Radio Co., Cedar Rapids, Iowa, and for the past several years has been head of that company's broadcast engineering department. He is a graduate of Purdue University.

John A. Green Co. will represent several well-known manufacturers as their sales engineer in the states of Texas, Oklahoma, Arkansas, Louisiana, and New Mexico. Equipment & Service will devote its services to industrial electronic, broadcast, and electrical engineering problems.

Mallard Supply Opens Store at Post, Tex.

E. L. Heard, president of Mallard Supply Co., Odessa, Tex., has announced the opening of a new store at Post, Tex., with Jim Furry as store manager and V. V. McGrew as field salesman.

This new store will come under the supervision of V. A. Nelson, Mallard general manager.

XUM

McCool Named to P.E.S.A. Board of Directors

M. G. McCOOL

According to a recent announcement, M. G. McCool, president of American Iron & Machine Works, Oklahoma City, has been named to the board of directors of Petroleum Equipment Suppliers Association.

St. Pierre Gets Hunt-Spiller Promotion

Harlow F. St. Pierre, formerly assistant sales manager, has been named manager of the industrial castings sales department of Hunt-Spiller Manufacturing Corp., Boston.

W. H. Siems Assumes New Post in Houston

W. H. SIEMS

W. H. Siems, former export manager of the New York office of Hughes Tool Co., has been appointed assistant general sales manager of the company, according to an announcement made by M. E. Montrose, vice president and general sales manager.

Siems joined Hughes in 1920, and has made his headquarters in New York for the past 20 years. While serving in the capacity of export manager he traveled in over 30 foreign countries in the firm's interest. In Houston he will assist in the general supervision and coordination of field sales and service activities, both domestic and foreign.

While Siems retains the major responsibilities in the foreign sales organization, O. B. Latrobe takes on added duties as foreign sales manager in New York.

Higgs Elected to Lane-Wells Board of Directors

Morton T. Higgs, manager of field operations of Lane-Wells Co., has recently been elected as a member of the board of directors, according to Walter T. Wells, chairman of the board. He fills one of the three newly created posts on the board. The other two placements are to be made at a later date.

In another release Lane-Wells announced the appointment of David W. Barnett as sales geologist at Calgary, Alta., Canada.

Higgs, who is also vice president and a member of the board of directors of Lane-Wells Canadian Co., has been connected with the petroleum industry for 30 years, having been a geologist for Interocean Oil Co., Atlantic Refining Co., Gulf Oil Corp., and Sun Oil Co. He was Gulf Coast regional manager for Sperry-Sun Well Surveying Co. before joining Lane-Wells as Gulf Coast sales manager in 1938. In 1939 he was promoted to division manager of the Gulf Coast division, and in 1947 he went to Los Angeles to take over his present position.

Barnett was formerly a geologist for Kennco Explorations of Canada where he worked in Northern British Columbia and did exploration work with Eldorado Mining & Refining Co. in the Lake Athabasca region. He graduated from University of Alberta with a B.S. in geology.

Byron Jackson Transfers Jordan to Corpus Christi

C. F. VINCENT

C. F. (Bud) Vincent, Mid-Continent sales manager, Byron Jackson Co., Oil Tool Division, Houston, has announced the placement of Milton R. Jordan to operate out of Corpus Christi.

Jordan will cover South Texas oil fields. He has been with Byron Jackson since 1946, working in the oil-tool department of the Houston plant.

W. H. Becker Organizes Atlas Pipe, Inc.

W. H. BECKER

W. H. (Buster) Becker, who since 1946 has been connected with Syd E. Culbertson Co. of Houston, has recently resigned to open his own sales offices for pipe for the oil industry, under the name of Atlas Pipe, Inc., at Houston.

Becker assisted in the early development of the American Association of Oil Well Drilling Contractors. Prior to his service in the Navy he served as office manager for Jack W. Frazier, an independent operator. Through mill and local contacts, Becker will be able to offer complete pipe service, including not only sale of new and used pipe, but also coating, wrapping, and testing facilities.

Porter President Visits Southwest Oil Areas

T. M. EVANS

T. M. Evans, Pittsburgh, president of H. K. Porter Co., Inc., was a visitor in the Southwest area the latter part of June, visiting the properties of the company's divisions: Jarecki Manufacturing Co., Hinderliter Tool Co., and Quaker Rubber Corp.

Evans was accompanied by C. R. Dobson, executive vice president of H. K. Porter Co., Inc. J. R. Keach, vice president and general manager, and H. M. Sossaman, assistant general sales manager, Quaker Rubber Corp., both of Philadelphia; and R. A. Campbell, of Hinderliter Tool Co., Tulsa.

Over 100 sales and field operating supervisors and representatives attended the annual sales conference recently held at the Hughes Tool Co. general offices in Houston. Sessions were conducted by M. E. Montrose, vice president in charge of sales; D. J. Martin, vice president in charge of engineering and research; and H. E. Rogers, vice president in charge of manufacturing. Following the general meeting, a special meeting was held with officials and export sales representatives from England, Europe, South America, and Mexico.

Beauchamp Elected to N.I.A.A. National Office

For the first time in the history of the National Industrial Advertisers Association, the panel of national officers includes a member from the oil-field-equipment suppliers' ranks. Edward E. Beauchamp, Lane-Wells' advertising engineer, was elected a national vice president of N.I.A.A. at that organization's national convention, held recently in Los Angeles.

In addition to his work of supervising Lane-Wells' diversified advertising programs, Beauchamp has, during the past year, served as president of the Southern California chapter of the N.I.A.A.

O. L. Lewis Joins Braun As Consulting Engineer

O. L. Lewis, formerly with the engineering and construction division of Jones & Laughlin Supply Co., Tulsa, has joined the staff of C. F. Braun Corp. in Los Angeles, as a consulting engineer.

Lewis is presently active on a number of the committees of the American Society of Mechanical Engineers, being chairman of a regional committee on section. In 1948 he served on the national nominating committee for A.S.M.E.

Tube Turns Names Two New Canadian Distributors

Thomas Robertson & Co., Ltd., of Montreal, and J. T. Wing & Co., of Windsor, Ontario, have been appointed as distributors in Canada for Tube Turns, Inc., manufacturer of welding fittings and flanges, according to an announcement by John G. Seiler, executive vice president and general sales manager.

Thomas Robertson & Co., one of Canada's largest suppliers of industrial products has branches in Ottawa and in the city of Quebec.

J. T. Wing & Co., which will represent both Tube Turns, Inc., and its subsidiary, Tube Turns of Canada, Ltd., has a branch in Chatham, Ont.

New Corporate Name for Beckman Instruments Maker

National Technical Laboratories, manufacturers of Beckman pH meters, spectrophotometers, automatic titrators, and other scientific and industrial instruments, has announced that it has changed its corporate name to Beckman Instruments, Inc. This action was taken for the purpose of associating the corporate name more closely with the trade mark of its principal products.

In the early years of National Technical Laboratories the manufacture of instruments was only one of several activities in which the company was engaged. In recent years the demand for instruments in modern industrial control operations has grown so large that the development and manufacture of instruments has become the major interest of the company.

No other changes are involved, either in company organization, policies, personnel, or products, or in the locations of its factory and service branches.

Oilwell Announces Sales Organization Changes

Paul H. Shepherd has been named assistant manager of the tubular department of Oil Well Supply Co., M. F. Hazel, general manager of sales, has announced. Shepherd, who has 34 years' service with Oilwell, has been assistant treasurer at the company's home office in Dallas for the past 2 years.

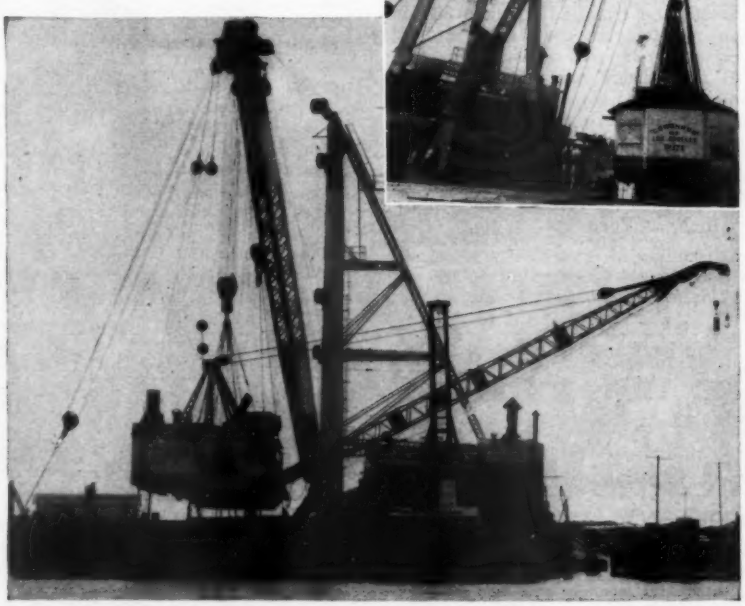
V. J. Waters, central Midwest division manager for Oilwell has announced that Don H. Schoonover has been appointed manager of the Big Spring, Tex., store, succeeding Jack Smith, who has been named district representative in the West Texas district. Schoonover, who has been with Oilwell for 18 years, has been a field representative at Wichita Falls, Tex., since September 1949. Smith joined Oilwell at Odessa, Tex., in 1946 and was made manager of the Denver City, Tex., store in October 1947.

F. D. Smith, division manager of Oilwell's Gulf Coast division, has announced three personnel changes. R. F. Cann has been named manager of tubular sales for the division, and J. W. Mays, formerly manager of Oilwell's Beaumont, Tex., store, has been assigned to field sales. Both will headquarter in Houston. J. T. Love, district representative, refinery and pipe-line equipment sales at Beaumont, succeeds Mays as store manager there.

(Continued on page 389)

Huge Derrick Barge for Offshore Operations

Johnson Western Co., San Pedro, Calif., has the largest privately owned derrick barge on the West Coast, intended for offshore operations on the Gulf and Pacific Coasts. The A-frame type derrick is mounted on a 160-ft. steel barge, steam powered and equipped with living quarters. It has a lifting capacity of 150 tons on the main fall blocks and 75 tons on each of the two side blocks. The big derrick is here shown making a lift of 140 tons in transferring a smaller derrick to a new barge.



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Hydraulic Casing Pulling Units, Hydraulic Jacks, Casing Spiders, Rings & Slips. Also,
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ENGINEER for economic analyses with major midwestern petroleum refiner. Must have petroleum or chemical industry experience in construction and equipment cost analysis. Graduate degree preferred, but a sound background of experience will be considered as a substitute. Reply in confidence giving full particulars to

Box D-604
THE OIL AND GAS JOURNAL
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Experienced ENGINEER familiar with Oil Refinery design and capable of estimating process equipment from flow diagrams.

Give full information, experience record and salary expected.

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ASPHALT refinery superintendent, 22 years general refinery experience, 8 years refinery superintendent desires position with small independent oil company with possibilities of working interest in refinery. Box D-597, The Oil and Gas Journal, Tulsa, Oklahoma.

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OFFERING 30,000 acres leases Valencia County, N. Mex., 10,000 Hidalgo County, 6,000 Torrance County, $1.50 acre—17,000 acres Wallace County, Kansas, $1. Write if interested, Box 2153, Denver, Colo.

FOR SALE: Oil and Gas Leases and Drilling propositions in Shallow territory of Allen, Simpson, and Warren Counties, Kentucky, W. P. Harley, Bowling Green, Kentucky.

IF you've got real oil proposition or royalty that you wish to sell, or any defaulted municipal or special assessment bonds, bring your deal to me. Dyer-OJ, 1635 Champa, Denver, Colorado.

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640 ACRES IN REAGAN COUNTY

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Patent #129
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Three Miles North of University Land

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WANTED: Producing properties, proven leases and leases near production. Prompt attention given to offerings. B. F. Gudwin & Co., Licensed Brokers, 220 Broadway, New York 7, N. Y.

OIL LEASE for sale in Miami County, Kansas: 80 acres in Peru, 80 acres in Squirrel sand; other acreages available. Claude D. Beets, Paola, Kansas.

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Offering 30,000 acres freehold leases 10c yearly rental under major company blocks in Southeastern Saskatchewan. $1.25 per acre. Box 355, Pittsburgh 30, Pa.

WANTED

WANT OIL, GAS lease or interest in royalty: San Luis Obispo, Monterey Counties, California. Mail description data to Box D-592, The Oil and Gas Journal, Tulsa, Oklahoma.

WANTED: SURPLUS Chemicals, Oils, Waxes, Solvents, Wastes and Residues of all kinds. Chemical Service Corporation, 98-06 Beaver St., New York 5, N. Y.

PATENT ATTORNEYS

PATENT Practice before U. S. Patent Office. Validity and Infringement Investigations and Opinions. Booklet and form "Evidence of Conception" forwarded upon request. Lancaster, Allwine & Rommell, Registered Patent Attorney, Suite 418, 815-15th Street, N.W., Washington 5, D. C.

EQUIPMENT MEN

(Continued from page 384)

Cann joined Oilwell 27 years ago and prior to this new appointment was manager of tubular sales for the California division. Mays joined Oilwell in 1949 and became manager of the Beaumont store in the same year. Love has been district representative, refinery and pipe-line equipment sales at Beaumont since joining the company in 1946.

Brush Acquires Interest In Switchgear Company

The Brush Group, which in addition to manufacturing large steam turbines, transformers, alternators, diesel locomotives, etc., at their Loughborough factory, own and control Mirrlees, Bickerton & Day, Ltd., Stockport; J. & H. McLaren, Ltd., Leeds; and Petters, Ltd., Staines; has acquired an interest in Switchgear & Erection Co. (Pty.) Ltd., of Germiston, Johannesburg, well known manufacturers of switchgear.

This latter company has been reformed and its title is now Switchgear & Engineering Corp. of South Africa (SECOR).

The present range of switchgear will be extended and the manufacture of small transformers and motors will shortly be introduced. Technical and design facilities of the Brush Group will be at the disposal of the new corporation and technical assistants will be provided from England.

Illinois Fields

(Continued from page 376)

Lawrence County: Hayes Drilling Co. and Big Four Oil & Gas Co. 1 Woodruff, SE NW SE 23-3n-13w, dry, TD 2,151 ft.

F. A. Stocker 1 Leather, SE SW SE 19-2n-11w, dry, TD 2,154 ft.

Madison County: William Krohn 1 Bircher, NW NW NE 31-4n-5w, dry, TD 2,766 ft.

Marion County: George H. Wickham 1 Spurgeon, NE SE SE 15-1n-3e, dry, TD 2,783 ft.

Montgomery County: Walter Duncan 1 Padgett, NE NW NW 17-8n-3w, dry, TD 2,807 ft.

O. A. Reed 1 Ravisky, SE SW NW 21-7n-4w, dry, TD 870 ft.

Wabash County: William T. Muller 1 Skelton, SW NW NE 11-1n-13w, dry, TD 2,697 ft.

Wayne County: Aurora Gasoline Co. 1 Writhrow, NW SW NE 6-2s-5e, dry, TD 3,135 ft.

INDIANA SUCCESSFUL WILDCATS

Dubois County: Stanley Krempp 1 E. Krempp, SW NW SE 6-2s-4w, IP 5 bbl., McClosky 630-92 ft., TD 692 ft.

Gibson County: A. W. Cherry 1 Miller, NE NW SW 12-2s-12w, IP 17 bbl., Cypress 1,990-2,010 ft. and McClosky 2,328-36 ft., TD 2,400 ft. (1 mile from Lyles pool.)

Knox County: B. L. S. Drilling C. 1 Schoot, NW SE SW 2-5n-7w, IP 51 bbl., McClosky 878-92 ft., TD 1,251 ft. (Opens Sandborn pool.)

Posey County: George C. Schoonmaker 1 T. E. Mumford, E½ NE NE NW 7-4s-13w, IP 50 bbl., Cypress 2,528-33 ft., and 2,547-66 ft., TD 2,566 ft. (Opens new pool.)

INDIANA WILDCAT FAILURES

Knox County: J. F. Balderson 1 Weitz, Militia Donation 169, 25-2n-9w, dry, TD 2,021 ft.

Warrick County: Fisher Oil Co. and C. E. O'Neal 1 Ellerbush, NE SW NW 34-6s-9w, dry, TD 1,899 ft.

C. E. O'Neal et al., 1 Pochlein, SW NE NW 27-5s-7w, dry, TD 1,584 ft.

WESTERN KENTUCKY WILDCAT FAILURE

Webster County: The Texas Co. 1 McMullen, NE NE NE SW 6-N-24, dry, TD 2,641 ft.

EASTERN KENTUCKY

ASHLAND.—Initial production of the discovery well of the new Briar Fork pool, Elliott County, has been established at 10 bbl. of oil per day from the Weir (Mississippian) sand (see details below). Meanwhile the offset test, Virgin Oil Co. 2 Henry Ferguson, 6-S-78 is drilling at 389 ft. One more location has been made and other tests are in prospect.

In the recently discovered Springfork field of eastern Breathitt County, United Carbon Co. is drilling at 990 ft. on the 26 E. J. Evans fee after topping salt sand at 698 ft. The same company is drilling at 1,114 ft. at its 27 E. J. Evans fee, 1,000 ft. southwest of the pool opener. Objective of both tests in Big lime (Mississippian), expected at about 1,150 ft.

In Big Sandy gas field, United Fuel Gas Co. has recently completed the 6574 H. C. Stratton in Pike County sector for 1,107,000 cu. ft. of gas daily from the Maxon (Mississippian) sand at 1,594-1,648 ft., total depth. A 48-hour rock pressure showed 465 psi.

EASTERN KENTUCKY SUCCESSFUL WILDCAT

Elliott County: Virgin Oil Co. 1 Henry Ferguson, 6-S-78, pumped 10 bbl. of oil per day from Weir sand, TD 896 ft., salt sand 175 ft., Little lime 340 ft., Big lime 375 ft., Keener 510 ft., Weir 821 ft.

CALENDAR

July

Pacific Coast Gas Association, annual convention, Seattle, Wash., July 31-August 3.

August

Interstate Oil Compact Commission, summer meeting, French Lick, Ind., August 3-5.

September

National Chemical Exposition, Chicago Coliseum, Chicago, September 5-9.

American Association of Petroleum Geologists Regional Meeting, Banff Springs Hotel, Alberta, Canada, September 5-8.

American Institute of Chemical Engineers, regional meeting, Minneapolis, September 10-13.

American Society of Mechanical Engineers, and Instrument Society of America, Municipal Auditorium, Buffalo, N. Y., September 11-15.

National Petroleum Association, Hotel Traymore, Atlantic City, N. J., September 13-15.

Instrument Society of America, annual instrument conference and exhibit, Municipal Auditorium, Buffalo, N. Y., September 18-22.

American Society of Mechanical Engineers, petroleum mechanical engineering conference, Roosevelt Hotel, New Orleans, September 24-28.

October

American Gas Association, annual convention, Atlantic City, N. J., October 2-6.

Mid-Continent Oil and Gas Association, Texas division, Dallas, October 4-5.

Petroleum Branch, American Institute of Mining and Metallurgical Engineers, Mid-Continent meeting, Roosevelt Hotel, New Orleans, October 4-6.

American Association of Oilwell Drilling Contractors, annual meeting, Mayo Hotel, Tulsa, October 9-10.

Petroleum Branch, American Institute of Mining and Metallurgical Engineers, West Coast meeting, Elks Club, Los Angeles, October 12-13.

Permian Basin Oil Show, Odessa, Tex., October 19-22.

Independent Natural Gas Association of America, annual meeting, Shamrock Hotel, Houston, October 23.

November

Mid-Continent Oil and Gas Association, Louisiana-Arkansas Division, annual meeting, Roosevelt Hotel, New Orleans, November 2-3.

California Natural Gas Association, Silver Anniversary, Los Angeles, November 9-10.

American Petroleum Institute, annual meeting, Biltmore and Ambassador Hotels, Los Angeles, November 13-16.

American Society of Mechanical Engineers, Hotel Statler, New York, November 26-December 1.

December

American Institute of Chemical Engineers, annual meeting, Columbus, Ohio, December 3-6.

NOMADS

Tulsa Nomads, third Friday of each month. After Five Room, Tulsa Hotel.

Dallas-Fort Worth Nomads, first Monday of each month, Greater Dallas Club.

Houston Nomads, second Monday of each month. Ye Ole College Inn, Houston.

Los Angeles Nomads, second Wednesday of each month. Jonathan Club.

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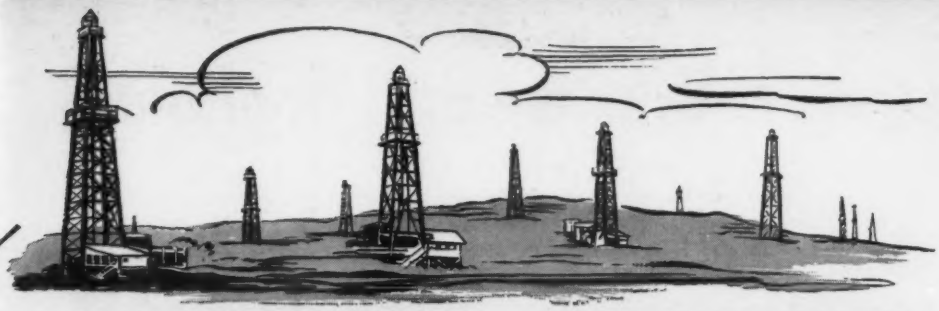

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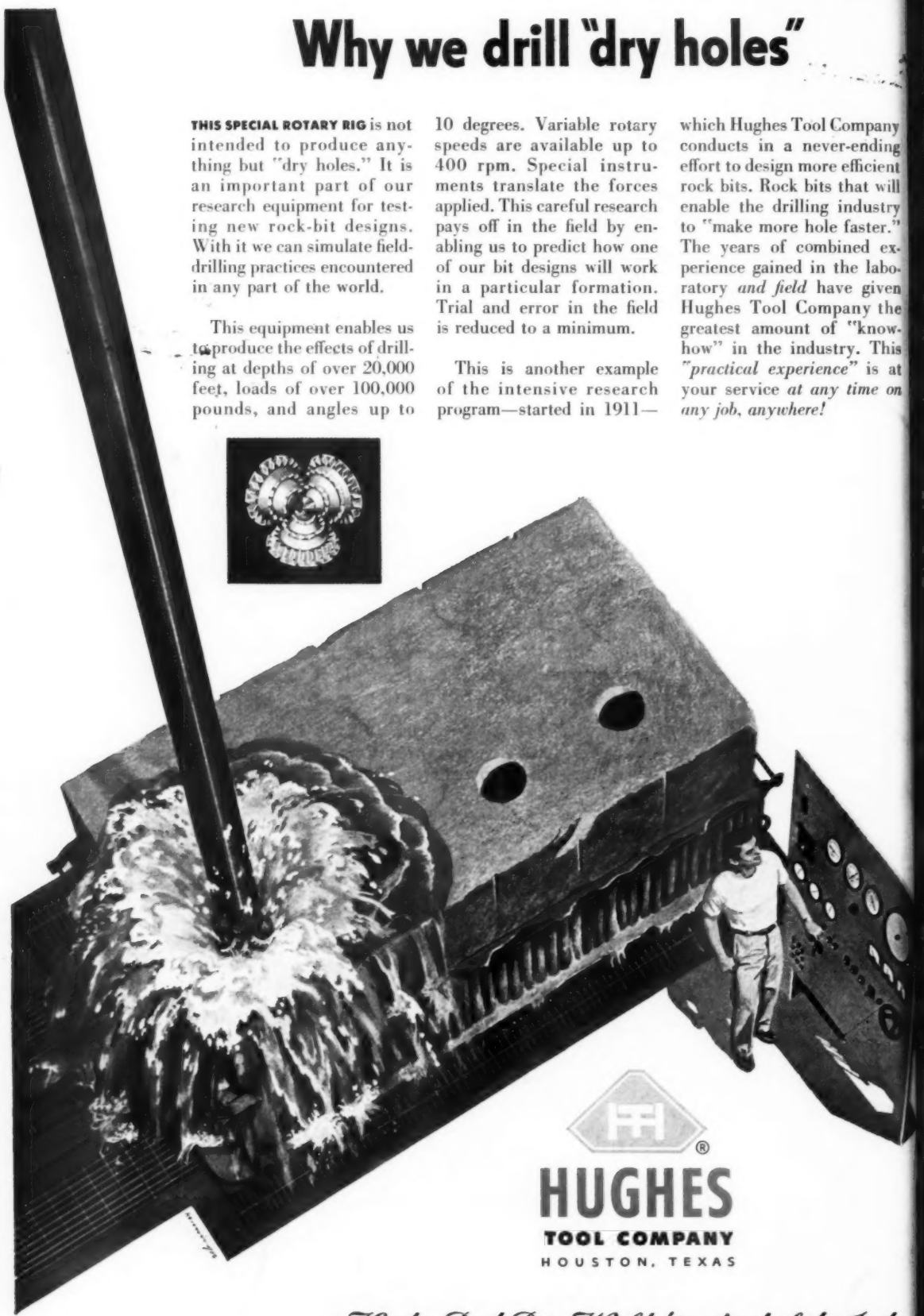

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